Vol. VI. — No. 9. September 1924.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION

[656 .257 (.42)]

All-electric power signalling installation and electric apparatus, Feltham yard, Southern Railway,

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Figs. 1 to 9, pp. 594 to 611.

(From the *Railway Engineer.*)

In 1921 a large marshalling yard on the hump principle, constructed by the London & South Western Railway Company at Feltham, was brought into operation (1). The first section for down traffic was brought into use on 21 May, 1921, mechanical signalling being employed temporarily. The up hump, with all-electric signalling, was put into service on 2 October 1921, while all-electric signalling replaced the mechanical signalling at the down hump on 2 April 1922.

A general plan of the yard is given in figure 3, from which it will be seen that the yard is divided into two main sections :

1. — The down reception sidings and marshalling yard.

2. — The up reception sidings and marshalling yard with a connection for exchange wagons or engines between the two hump boxes. There is also : 1° a small grid of eight sorting sidings at the western end of the yard for marshalling the wagons of a train in station order; 2° wagon repair shops; 3° engine shed; 4° cattle pens; and 5° general offices.

At a yard of this character every facility must be provided to permit quick operations of the points, and the time taken by the electric motors to change the position of the points should be very short. The specification for the electric motors at the Feltham yard called for the movement of the point tongues from one side to the other in not more than one second. They were supplied by Siemens Bros., Ltd., and, in fact, complete the movement in three-quarters of a second or 20 complete movements in 15 seconds.

(1) See *Bulletin of the International Railway Congress Association*, for May 1924, p. 396, which contains a paper relating to this marshalling yard and its locomotive shed.

The entrance to and the exit from the yard, from and to the main line, respectively, at the eastern end is controlled by the Feltham Junction signal box, which is manually operated and mechanically worked. Similarly, the entrance to the western end of the yard from the up main line and the exit to the down main line is controlled by the Feltham east signal box, which also controls the Feltham Station signals and a small ground signal frame. Both are manually operated and mechanically worked signal boxes. The Feltham Junction east and ground frame boxes are new, but the Feltham west box, which controls the public level crossing, has been altered and adapted to the new conditions. The points, facing point lock bars and signals connected to these boxes, are mechanically worked, except the distant signals, which are worked by electric motors. The ordinary standard bell block working between the signal boxes is in operation, the trains being signalled from one box to the next by the standard block bell code, but, in place of the locking feature of the lock and block system, the trains themselves automatically operate the track circuits, which provides the necessary protection. The movements of the trains through the sections are indicated on the signal box diagram to the signalmen by means of the track-circuit section indicators, while the position of the facing points are detected by electric point detectors, which are repeated in the signal box.

The whole of the signals and points connected to the two hump boxes are worked by electric motors operated from a push-button signal frame laid out geographically to correspond to the lay-out of the yard. The track circuiting covers a length on the main lines of 4.44 miles, and in the sidings 5.6 miles, the current for the whole of these being supplied from the accumulators in the central power house.

Electric clocks on the « Synchronome » system have been installed in all the offices, signal boxes and cabins in the yard, including a four-faced clock on the tower of the office buildings. A central battery telephone switchboard is installed in the telephone room, to which all offices, yard foremen's cabins, and signal boxes are connected. The switchboard also serves for centralising the company's telephone system in the Reading-Windsor-Ascot-Frimley area.

The electric energy for working the whole of the electric signals, point movements, track circuit, telephone switchboard and the control apparatus is taken from the signal and lighting mains, which are fed from the Durnsford Road power house at 3 300 volts at 75 periods, and extend over the electrified area. These mains were extended from Twickenham to a small kiosk near the central signal power house at Feltham, where by a 40-kw. static transformer the voltage is transformed from 3 300 volts to 220 volts for electric lighting and signal purposes. The signal electric supply is taken from the 220-volt bus-bar in the kiosk to terminals marked + and — on the power switchboard. The current is received through 100 ampere fuses to the main switch, starting switch, with no-load and overload release apparatus, thence to the alternating current synchronous motor and back by the return leads to the switchboard.

Electric point movements.

The total number of electric point movements in the area is 43. Owing to the necessity in hump-yard shunting of being able to set or reset a route quickly, it is desirable that the point tongues should be able to move from one position to the other in as short a time as possible. The specification for the motors stipulated therefore that the points should be completely reversed in not more than one second. Hitherto

the electro-pneumatic system had been used for power-worked gravitation yards, but this entailed two sources of power, electric and pneumatic compressors, and the necessary duplicate systems of underground wires and air pipes. It was also required to arrange that if a pair of points were run through in the trailing direction (*i. e.*, with the points set against that movement) the point movement or electrical apparatus should not be damaged, as any such damage would cause delay in the shunting work, perhaps at a busy time. With pneumatically worked point movements this was easily achieved, but with electric point movements shearing bolts had previously been used to save the electric machinery being damaged. In a hump yard the delay caused by renewing a shearing bolt would have been serious, as at least two sidings would have been put out of use for not less than 20 minutes under the most favourable circumstances.

Arrangements were therefore made to connect the force rod of the points to the electric point movement by means of a « Williams » spring. In ordinary working the spring is strong enough to transmit the motion of the electric motors as if the connection were direct and solid. If, however, a vehicle runs through the points in the trailing direction, the point tongue is moved over and compresses the « Williams » spring after the vehicle has passed through. The spring then elongates to its original length and forces the point tongue against the rail, so that no damage is done to the points or to the electric point movement.

The electric point movements, complete with electrical point detectors and change-over switches for reversing the direction of the current through the field magnet coils of the motor, were supplied by Siemens Bros., Ltd. The motors are series wound, work at 112 volts, starting current 6 amperes, running current 4.5 amperes, and the reversal of the position of the points from one route to the other is completed in 0.75 second. The points are quite free during the whole movement, inasmuch that the motor can be stopped and reversed at any position of its travel. Tests show that the points can be reversed 20 times in 15 seconds. A circuit diagram of the point movement and change-over switch is given in figure 1.

The rotary motion of the armature of the motor is transmitted by means of a gear wheel fixed to an armature spindle 2 15/16 inches diameter through a gear wheel 3 15/16 inches diameter to the driving gear wheel 3 3/8 inches diameter, fitted by means of a clutch to the spindle of the worm gearing which rotates a circular cam on which a stud is fixed. The stud engages with a butterfly escapement crank, and as the stud on the circular cam revolves it engages with the butterfly, and thus reverses the point tongues which are connected by a rod to the crank of the butterfly. The first motion of the force rod causes the electric point detector contacts to break, which disconnects the circuits of the point detector indicator in the push-button signal frame and the white light goes out, indicating that the points have moved. The points then complete reversal movements, and at the moment of doing so the change-over switch in the point detector box is thrown from, say, the right-hand position to the left-hand in readiness for the next reverse move. The movement of the change-over switch from the right disconnects the point movement circuit and the current ceases to pass through the motor, which pulls up practically at once; there is a little over-run which is allowed for. The tongues of the points have now completed their movement and lie in the correct position for the route set. This connects the circuit of the electric point detector indicator in the push button

signal frame, and the white light (between the two push buttons referring to the particular points) glows again, this indicating to the signalman that the points have answered to the motion of the push button. The change-over switch in the point detector box is of the quick-break type, as the voltage is 112 volts.

The electric motor starts and runs light for a very small part of its movement and revolves 16 times to complete the movement of the points, and a 10-ampere fuse is fitted in each point movement circuit to limit the current passing. If there should happen to be an obstruction between the tongue of the points and the stock rail the electric motor overcomes the friction of the clutch and runs a little slower. A test was made with a motor running on the

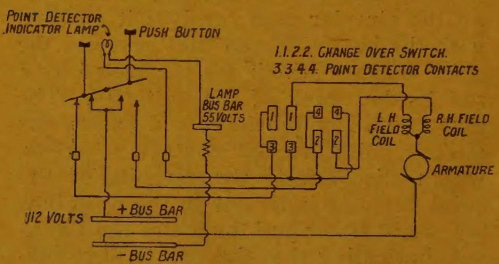


Fig. 1.
Circuit diagram of electric point movement.

clutch for 30 minutes continuously without any effect on the motor and practically none on the clutch, but had there been any it has been arranged that the friction between the electric motor and the clutch can easily be readjusted. In practice, however, the signalman in such cases sees immediately by the point detector lamp on the push button frame not lighting up that the points have not answered the movement of the push button he has operated, and he immediately reverses the points and tries again to see if he can remove the obstruction. He would, for instance, do this under the general regulations during the time snow was falling. The travel of the point tongues from one side to the other is 4 inches. The electric detector circuit is also shown in figure 1.

Electric signals.

There are 6 distant signals, 2 stop signals, 21 ground signals worked by electric signal movements of the well-known Siemens type, series wound. The resistance of the armature of electric signal motor is 5 ohms, field magnets 9 ohms. The armature revolves 65 times to pull the arm from the horizontal to a diagonal position of 45°, and the time taken to pull off is 1.75 seconds. The arm returns to the horizontal or danger position immediately it is released. The whole of the signals are worked from the 112-volt power mains. The distant and stop signals require 1.14 amperes and the ground signals 1.2 amperes. Each of the signal motors is connected to a switch or contact maker fitted to the signal lever in the signal box. When the lever is pulled over to place the signal arm in the off position the contact is made.

The circuit of the signal motor is taken through contacts of various controlling relays, such as point detector relays or slotting circuit closers on the controlling signals direct to the terminals of the electric signal movement. When the signal lever is pulled, and provided that all the control contacts are made a current of about 1.14 amperes passes through the motor momentarily as a starting current, which falls to about 1.10 amperes whilst running, until the arm has completed its movement from horizontal to 45° in the lower quadrant. Then the motor is automatically cut out of circuit and a magnetic clutch which holds the arm in the off position is connected into the circuit by means of a

change-over switch. The resistance of the clutch coil is 600 ohms, and a current of 0.135 ampere passes continuously until one of the control contacts, say, a track circuit relay which has been operated by a train passing over the section or the signal lever contact, is broken. In either case the current ceases, and the clutch being demagnetised the signal arm is released and goes to the horizontal position by means of a counterweight of 20 lb.

To avoid too great a jar on the signal post and apparatus a pneumatic dashpot is provided and comes into action when the arm is released. The signal motor will operate on voltages from 85 to 120 volts, and runs a little slower as the voltage decreases. This is very convenient, as it allows a wide percentage of drop in cases of distant signals which may be 1 000 yards or more away from the signal box. The electric motors for ground signals are slightly smaller than those for stop signals. The

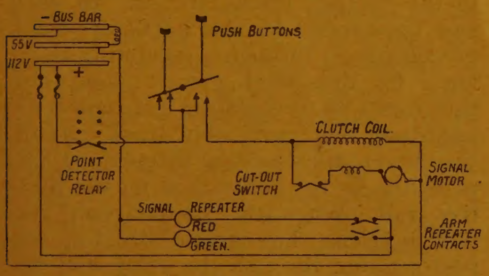


Fig. 2. — Electric signal movement.

starting current is 1.2 amperes, the running current 1.2 amperes, and the time to complete the movement, 0.6 second. The armature revolves 14 times, and its rotary movement is transmitted through two gear wheels and a worm gearing to the arm. No dash-pot is provided in the case of ground signals. A typical circuit diagram of an electric signal movement and controlling apparatus is given in figure 2.

Track circuits.

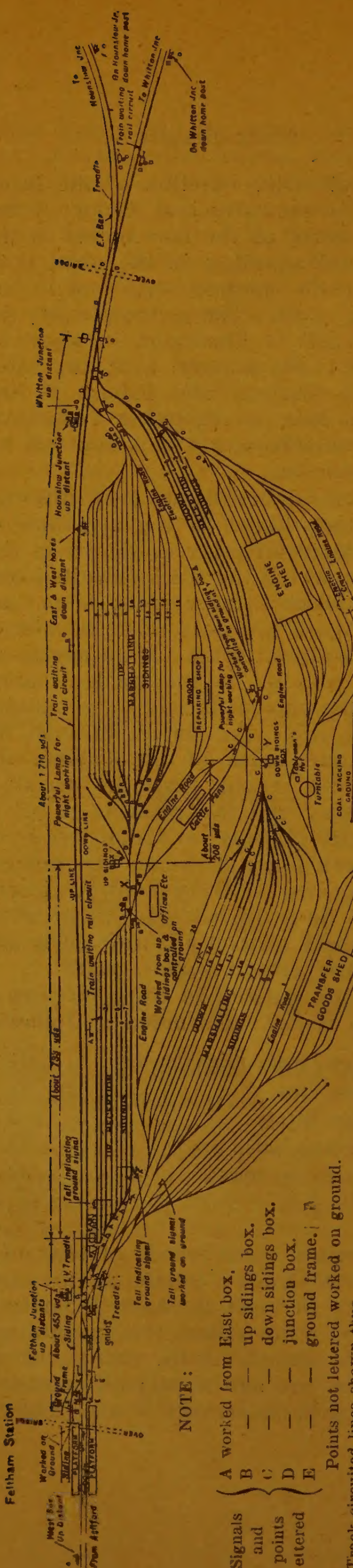
The automatic function of the track circuits is the principal factor of the safety control of the movements of the traffic and shunting in the area, both on the main running lines and in the shunting yard. The principle of the track circuit is illustrated in figure 4, where *a* is the battery, *b*, b_1 the rails, C, C the sleepers and ballast, R, the relay, *d* fuse, *e* regulating resistance, *f* front contacts, and *g* back contacts for control circuits.

The control circuits are taken through the contacts fixed to the armature of the track-circuit relay as shown in figure 4, in which the track-circuited section is clear. The current from battery *a*, figure 4, passes through rails to the track-circuit relay. If an engine or vehicle runs on to the track-circuited section the current is said to be shunted from the relay and passes through the wheels and axles of the engine, the consequence being that the armature drops away and the contacts in all of the control circuits in which this relay is connected are broken. The apparatus connected to these control circuits is then de-energised and inoperative, but the back contact *g* is now made and the control circuit contact made.

The total number of track circuits in the area is 129, distributed as follows :

Feltham Junction signal box. . . .	24
Feltham East	24
Feltham West	5
Feltham up hump box	38
Feltham down hump box.	38
	129

Particulars and records of tests of a number of track circuits in the area are given in table 1. As will be seen, the lengths, the ballast, the weather and other conditions of the track circuits are so various and widely different that the records show very completely the



NOTE:

Signals and points lettered: A worked from East box. B — — up sidings box. C — — down sidings box. D — — junction box. E — — ground frame.

Points not lettered worked on ground.

Track circuited lines shown thus ....

Other lines shown thus ....

Fig. 3. — Diagram showing the track circuiting of Feltham marshalling yard (complete scheme).

conditions that have to be met in installing and maintaining direct-current track circuits.

Figure 5 is a diagram showing the distribution of the track circuits and the voltage and currents in the main distribution leads. It will be seen that all the track circuits are fed from a central accumulator, 28-volt battery, the terminals of which are led to the power switchboard, where the outgoing current passes through an ammeter, through separate fuses to the several groups of track circuits and control circuits, so that a short circuit or fault on a circuit in one group is unlikely to cause interference with the other track circuits or control circuits, whether in the same group or not. A pair of main conductors for each group are run from the sectionalising fuse on the switchboard to the distributing point for each group. The current for all the track circuits in the group is then led through a main regulating resistance where it divides to the various track circuits. In each case the current for that particular track circuit passes through a regulating resistance for that track circuit alone, and this forms the regulating resistance for adjusting that particular track circuit, the current then passing through a 1-ampere fuse to the connection on the positive rail. When the track-circuit section is clear the current divides, one part passing through the relay and the other part leaking across the ballast between the two rails to the negative or return rail. The electric locks are then free for the signal levers, and the indicators intimate to the signalman that the section is clear, but if a train enters the section the signal levers are locked and the indicators, as already explained, indicate that the section is occupied. As will be seen from figure 4, a positive and negative lead is run for connecting the battery to the rails, so that the current is led by the positive conductor and returns by the negative return conduc-

tor. Similarly, two wires are connected from the rails to the relay terminals. This is the usual practice, and has been followed as regards the main-line track circuits at Feltham, but a novel method has been introduced in respect of all the track circuits in the gravitation sidings. One rail has been divided into insulated sections as required for the track-circuit positive rail, and the opposite rails, crossings, etc., have been bonded together with No. 8 S. W. G. (350 lb. to mile) G. I. wire, and all these (return) rails interbonded as far as possible to form what may be called a good common return or earth. The negative pole of the battery is connected direct to this common return rail near the power house. One lead is run from the positive bus-bar at the distribution point to the battery end of the track circuit. The current passes through this positive and insulated section of rail to the relay at the opposite end of the track circuit and to the negative rail, and thence direct through the common return rail to the connection on the common rail to the negative of the battery, thus a separate return wire from each track circuit at the battery end being dispensed with, or in other words, one leading wire to each track circuit is saved. This will result in considerable economy, especially if the battery ends of the track circuit are far away from the distributing points. It will be seen from the track circuit records of the up and down hump boxes that the arrangement is successful, and it may be added that no difficulty whatever has been found in maintenance or working since they were brought into use in October, 1921.

All telegraph, telephone and track-circuit wires are run underground in keys bitumenised fibre conduit 3 and 4 inches diameter, surrounded by 6 inches of concrete. There are 3 1/4 miles of such conduits in the area. All the track-circuit relays and control apparatus, positive and negative bus bars for point and signal movements, track-circuit leading wires, regulating resistances and fuses have been placed in the relay rooms under the hump boxes and in the lower part of the signal boxes, so that no cupboards or locations whatever are on the ground, which is free for the movements of the shunters. The leading wires for each track circuit are run direct from the track-circuit bus-bar underground to the connecting points on the ground. Similarly with the electric point movement, the special feature being that there is no apparatus above the surface of the ground. Further, the concentration of the terminals of the positive and negative leads of the track circuits, the track-circuit relay regulating resistances and terminals and fuses of electric point and signal movements in one room, allows of any part of the apparatus to be examined and tested easily and quickly.

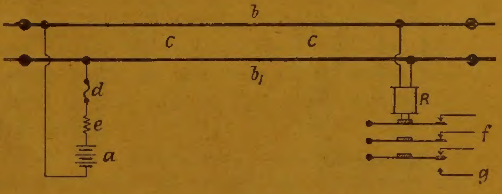


Fig. 4. — Diagram showing principles of track circuit.

Take track circuit A, Feltham East, table 1, as a typical case of connecting the track circuits to the common supply. At the time the weather was slightly damp. The length of the track circuit is 311 yards, the length of the leads from rails to relay terminals 35 yards, *i. e.*, a total of 70 yards, No. 18 S.W.G. copper wire, insulated with maconite; at the battery end the leads are 135 yards. The regulating resistance is 50 ohms. The D.O.P. at the terminals of the distribution bus-bar in the east box is 13.4 volts, and after passing through the common regulating resistance the D.O.P. on the track-circuit distribution bus-bar was 12.1 volts. The D.O.P. across the

regulating resistance was 11 volts. The D.O.P. on the rails at the battery or feed end of track circuit was 1.13 volts, this falling to 1.11 volts on the rails at the point, 311 yards away, where the track-circuit relay was connected to the rails.

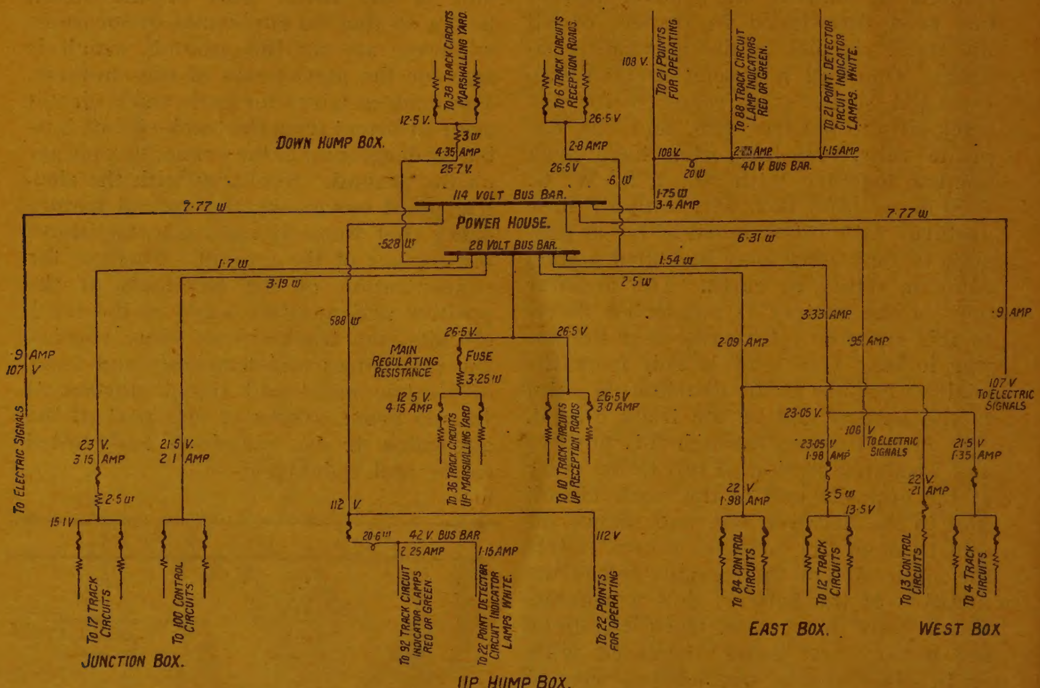


Fig. 5. — Load on 114-volt and 28-volt power mains at Feltham marshalling yard, Southern Railway.

There was thus a fall of potential of 0.02 volt in the rails themselves, taking the two together as 622 yards long. The total current passing to the track circuit from positive bus-bar was 245 milliamperes of which 132 milliamperes passed through the relay, and the remainder, 113 milliamperes, leaked from the positive rail to the negative, or return rail, through the ballast, which is Meldon quarry broken stone. The resistance of this path is called the insulation resistance or ballast resistance of the track circuit, which in this case is 11.0 ohms. The resistance of the relay is 9.3 ohms. The chairs are fastened to the sleepers by fang bolts. The maximum resistance placed across the rails that would cause the armature of the relay to « drop away » was 1.3 ohms. When the two rails were short-circuited, as they would be when an engine or train was standing or running over it, the total current passing from the positive bus-bar was 265 milliamperes, practically all of which passed from one rail to the other through the wheels and axles of the vehicles and practically none through the track-circuit relay.

The regulating resistances are of the fireproof porcelain cement type, and were ordered in units of 50, 60, 70, 80, 90, 100, 6, 8 and 10 ohms each to carry a maximum of 0.333 milliampere. They

consist of wire wound on an oblong bobbin, the wire being surrounded by porcelain. The unit suitable for each track circuit is selected and can easily be changed if necessary. The resistances of the units are those when maximum current passes when the unit is warm.

The case of two track circuits No. C and D at the west box is of interest. Owing to the shortness of time the mains could not be extended to feed these two track circuits, and it was therefore arranged to provide gravity batteries temporarily, but they were subsequently changed over to the central battery supply. The benefit as regards the train shunt resistance is seen from the record, as are the differences between the records of the other functions under the two sets of conditions.

The common regulating resistance for each group and the separate regulating resistance for individual track circuits were provided with a view to make any adjustment in the ultimate regulating resistance of the track circuits that may be found necessary between very wet and very dry weather. This was effected by means of the common regulating resistance rather than altering the regulating resistance of each individual track circuit, as it is to be expected that the effects of any change of the weather would affect all the track circuits comparatively similarly.

In some cases the records show the currents through the relays to be larger than they should be, and in these cases the necessary adjustments have been made.

To ensure that the rails are electrically connected together, in addition to the ordinary fish plate, the ends of the rails are bonded together by two G.I. wires, No. 8 S.W.G., 350 lb. per mile, 6 ft. 6 in. long, the resistance of the two wires in parallel being 0.011 ohm. The wires are connected in the rails by means of grooved cast steel channel pins, a hole 9/32 inch being bored in the web of the rail into which the ends of the G.I. wire laid in the grooved pins are driven into position as quickly as possible after the hole has been drilled, so that the inside of the hole and the outside of the pin and wire are all clean, and good electrical contact is made between them.

As already pointed out, all the wires are underground, but where it is necessary to lead the wires to connect to the rails, at the battery and relay ends of the track circuits, a concrete corner or joint box is made and placed underground. A 3/4 inch iron pipe suitably shaped is fixed in one side and led up straight, the end of which is near the rail, and to this end a rubber tube 6 inches long is clamped, while to the other end of the rubber tube a short brass tube, with a three-way terminal of the British Power Railway Signal Company's pattern, is clamped. The wire from the relay or battery is fixed to one terminal and the ends of the two G.I. wires to connect to the rail are fixed to the other two of the three-way terminal; the opposite ends of the two G. I. wires are fixed to the rail in the way previously described.

The G.I. bond and connecting wires are subjected to excessive vibrations as the trains pass over them, and to avoid damage to them the ends of the 6-ft. 6 in. band wires are joined to the rail at points 5 ft. 9 in. apart, an S curve being formed at each end to ease the effects of the vibration. For the same reason the connecting G.I. wires from the three-way terminal to the rail is wound in a circle 2 inch diam., otherwise, if the wires are put in straight, it is found they break off after they have been in use a very short time.

The track-circuit relays are of the American circular pattern, made by the General Electric Company, Ltd., to the railway company's specification. The pick-up current is 65 milliamperes, the maximum drop-away current 45 milliamperes, and the resistance 9.0 ohms, a

TABLE I. **Record of te**

Test number.	DESCRIPTION OF TEST. Test record No.	1	2	3	4
1	Date of test	15 Feb. 1922.	15 Feb. 1922.	15 Feb. 1922.	15 Feb.
2	Locality of track circuit	East.	East.	East.	Eas
3	Name of track circuit	A	B	C (main)	C (bran
4	State of weather	Slight damp.	Dry frost.	Damp.	Fine
5	Length of track circuit, in yards	311	122	754	..
6	Length of leads relay end, in yards ..	35	150	20	..
7	Length of leads battery end, in yards	135	20	60	..
8	Regulating resistance, in ohms	50	80	80	.
9	Current through T.C. with relay disconnected, in milliamperes	220	133	...	28
10	Current through T.C., relay disconnected but rails short-circuited relay end, in milliamperes	260	165	...	32
11	Voltage across regulating resistance, relay disconnected, in volts	11	10	...	2
12	Ditto with rails, short-circuited relay end, in volts	...	...	...	..
13	Voltage feed end when relay disconnected, in volts	...	...	...	...
14	Current to T.C. when relay connected and T.C. complete and clear, in ma.	245	150	300	30
15	Voltage at T.C. supply, bus bar ditto, in volts	13.4	13.4	27	..
16	Voltage on terminals of regulating resistance, ditto, in volts	12.1	12 45	25	2
17	Voltage on track side of regulating resistance, in volts	..	...	2.0	2.0
18	Voltage on rails, feed end of T. C. ditto, in volts	1.13	1.09	1.07	1.
19	Voltage on rails, relay end of T. C. ditto, in volts	1.11	1.07	1.07	1.
20	Voltage at relay ditto, in volts	1.11	0.87	1.05	1.
21	Current passing through relay ditto, in milliamperes	132	109	127	14
22	Current passing into T.C. when T.C., with T. C. short-circuited, is occupied, in milliamperes	265	165	...	32
23	Train shunt resistance pick-up, in ohms	2.8	5.8	2.6	...
24	Train shunt resistance drop-away, in ohms	1.3	3.0	1.3	...
25	Resistance of T.C. relay, in ohms	9.3	9.3	8.8	8.
26	Weight of rails in T.C. section, in lb.	90 BS	90 BS	90 BS	...
27	Arc trenails T, or fang bolts F, used	F	F	F	...
28	Class of ballast and road bed	Stone.	Stone.	Stone.	...
29	Number of points and crossings in T.S. section	3 points.	1 point.	Nil.	...
30	Insulation of T.C. rails, or ballast resistance, in ohms	10.81	24.7	6.5	8.0

NOTE. — In line 5 where two lengths are given there are two positive rails in parallel, near points.

current track circuits. TABLE I.

	7	8	9	10	11	29	30
1922. ·. p.	15 Feb. 1922. East. H Slight damp.	15 Feb. 1922. East. J Slight damp.	15 Feb. 1922. East. K Slight damp.	13 Feb. 1922. East. L Dry frost.	13 Feb. 1922. East. M Fine dry frost.	20 Feb. 1922. Junct. A Fine damp after rain.	April 1922. Junct. A_1 Fine aft r rain.
				65	27		24.6
	110	430	316	63	28	405	28.0
	130	45	45	65	25	25	108
	20	20	500	12	65	610	130
	80	50	50	70	90	70	90
	130	230	230	160	109	170	120
	160	250	220	175	148	195	160
	9.9	11.4	10.2	11.2	9.5	...	...
	...	...	...	...	..	...	0
	...	...	...	...	...	1.38	4.0
	160	240	240	180	140	195	145
	13.4	13.4	13.4	13.4	13.4	11.2	15.0
	12.5	12.1	11.8	12.65	12.6	12.9	13.1
	..	...	...	..	...	1.3	1.6
5	1.05	1.18	1.16	1.05	0.99	0.85	1.31
)	1.02	1.16	1.16	1.04	0.99	0.84	1.31
1	0.9	1.10	1.14	0.90	0. 0	0.84	0.91
	119	129	140	114	113	102	126
	160	255	225	175	150	195	160
	5.9	2.9	2.7	4.5	3.0	6.3	7.0
  5	3.2 8.85 90 BS	1.7 9.0 90 BS	1.8 8.9 90 BS	2.2 9.25 90 BS	1.8 9.15 90 BS	2.2 9.0 90 BS	3.8 8.75 90 BS
	F Stone.	F Stone.	F Stone.	T Ashes.	T Ashes.	F Stone.	T Ashes.
s :.	1 crossing.	Nil.	Nil.	5 pairs points.	1 pair points.	Nil.	1 pair points.
	25.7	10.5	12.5	15.41	38	8.11	33

NOTE. — In 27 F = Fang bolts, T = Trenails.

TABLE I. (*Continued.*) **Record of te**

Test number.	DESCRIPTION OF TEST. Test record No.	31	32	33	34	3
1	Date of test	20 Feb. 1922.	April 1922.	17 Feb. 1922.	April 1922.	17 Fel
2	Locality of track circuit	Junct.	Junct.	Junct.	Junct.	Ju
3	Name of track circuit	B	B_1	C	C_1	
4	State of weather	Fine damp after rain.	Fine after rain.	Damp.	Fine after rain.	Da
5	Length of track circuit, in yards	433	28.6 33.6	268	40.3 44.6	1
6	Length of leads relay end, in yards	25	75	130	42	1
7	Length of leads battery end, in yards	160	105	175	50	2
8	Regulating resistance, in ohms	60	80	50	60	
9	Current through T.C. with relay disconnected, in milliamperes	205	150	240	210	1
10	Current through T.C., relay disconnected but rails short-circuited relay end, in milliamperes	225	180	260	240	2
11	Voltage across regulating resistance, relay disconnected, in volts	...	...	...	...	.
12	Ditto with rails, short-circuited relay end, in volts	...	0	...	0	.
13	Voltage feed end when relay disconnected, in volts	1.38	2.7	1.5	2.4	2
14	Current to T.C. when relay connected and T.C. complete and clear, in ma.	225	165	260	220	2
15	Voltage at T.C. supply, bus bar ditto, in volts	14.2	15.0	14.8	15	14
16	Voltage on terminals of regulating resistance, ditto, in volts	13.0	13.5	12.4	13.6	12
17	Voltage on track side of regulating resistance, in volts	1.2	1.4	2.4	1 4	2
18	Voltage on rails, feed end of T. C. ditto, in volts	0.80	1.19	0.98	1.23	1
19	Voltage on rails, relay end of T. C. ditto, in volts	0.75	1.19	0.95	1.23	1
20	Voltage at relay ditto, in volts	0.74	0.83	0.75	0.84	0
21	Current passing through relay ditto, in milliamperes	88	114	85	102	
22	Current passing into T.C. when T.C., with T. C. short-circuited, is occupied, in milliamperes	225	180	260	240	2
23	Train shunt resistance pick-up, in ohms	6.8	7.0	8.7	5.9	9
24	Train shunt resistance drop-away, in ohms	2.5	3.4	3.2	2.3	3
25	Resistance of T.C. relay, in ohms	8.77	9.15	9.2	9.1	9
26	Weight of rails in T.C. section, in lb.	90 BS	90 BS	90 BS	90 BS	90
27	Arc trenails T, or fang bolts F, used	F	T	F	T	I
28	Class of ballast and road bed	Stone.	Ashes.	Stone.	Ashe .	St
29	Number of points and crossings in T.S. section	Nil.	1 pair points.	2 pairs points.	6 pairs points.	1 p
30	Insulation of T.C. rails, or ballast resistance, in ohms	6.7	18	6.25	11.4	11

NOTE. — In line 5 where two lengths are given there are two positive rails in parallel, near points.

…current track circuits. **Table I.** (*Continued.*)

	38	39	56	58	59	60	61
1922.).	16 Feb. 1922. Junct. H Damp.	20 Feb. 1922. Junct. J Fine damp after rain.	21 Feb. 1922. West. A After heavy rain	21 Feb. 1922. West. C Drying wind after rain.	21 Feb. 1922. West. D Drying wind after rain.	25 June 1922. West. C Fine dry wind.	25 June 1922. West. D Fine dry wind.
	77 32 60 130 70	354 8 60 50	496 235 290 35	436 10 8 ...	620 10 8 ...	436 10* 570 80	620 10* 1010 80
	170	235	558	200	345	200	290
	195	265	590	600	610	245	310
	...	...	. .	...	...	...	...
	. .	...	...	...	...	0.66	0.59
	2.2	1.7	1.38	1.42	1.13	3.95	2.30
	195	265	560	280	385	230	300
	14.8	13.7	23.0	1.22	1.02	20.5	20.5
	12.4	12.5	19.9	Gravity	battery †	19.0	19.2
	2.4	1.2	3.0	1.22	1.02	1.98	1.75
	0.98	0.99	1.13	1.20	1 02	1.25	1.11
	0.97 0.81	0.98 0.98	1.1 0.53	1.20 1.20	1.02 0.96	1.24 1.24	1.10 1.08
	94	110	123	135	110	148	124
	185	265	590	610	630	245	310
	9.0	3.4	1.7	0.9	0.9	2.2	2.1
	4.3 9.1 90 BS	1.3 9.1 90 BS 90 SW	0.4 4.5 90 BS	0.3 8.75 90 BS	0.3 8.7 90 BS	1.1 8.75 90 BS	1.0 8 7 90 BS
	F Stone.	T Stone	F Stone.	F Stone.	F Stone.	F Not insulated.	F Insulated except 15 yards.
	1 crossover.	1 point 1 crossover.	3 pairs points.	Nil.	1 pair points 1 crossing.		
	9.75	7.25	2.48	7.1	3.25	19.75	7.9

Note. — In 27 F = Fang bolts; T = Trenails. * Mostly open wind. † 2 cells in series.

TABLE I. (*Continued.*) **Record of t**

Test number	DESCRIPTION OF TEST. — Test record No.	104	105	106	107	
1	Date of test	April 1922.	April 1922.	April 1922.	April 1922.	Apri
2	Locality of track circuit	Down hump.	Down hump.	Down hump.	Down hump.	D hu
3	Name of track circuit	A_1	A_2	A_3	B_1	
4	State of weather	Fine after rain.	Fine after rai .	Fine after rain.	Fine after rain.	F afte
5	Length of track circuit, in yards	15 14.3	19.3 17.5	35	11.6 13.3	
6	Length of leads relay end, in yards	30	47	68	82	
7	Length of leads battery end, in yards	45	66	82	94	
8	Regulating resistance, in ohms	100	100	100	100	
9	Current through T.C. with relay disconnected, in milliamperes	80	83	74	87	
10	Current through T.C., relay disconnected but rails short-circuited relay end, in milliamperes	122	121	125	121	
11	Voltage across regulating resistance, relay disconnected, in volts	...	...	...	...	
12	Ditto with rails, short-circuited relay end, in volts	...	...	...	...	
13	Voltage feed end when relay disconnected, in volts	4.3	3.8	4.6	3.4	
14	Current to T.C. when relay connected and T.C. complete and clear, in ma.	113	113	115	112	
15	Voltage at T.C. supply, bus bar ditto, in volts	12.5	12.5	12.5	12.5	
16	Voltage on terminals of regulating resistance, ditto, in volts	11.3	11.3	11.1	11.2	
17	Voltage on track side of regulating resistance, in volts	0.93	0.98	1.09	1.04	
18	Voltage on rails, feed end of T. C. ditto, in volts	0.82	0.82	0.96	0.90	
19	Voltage on rails, relay end of T. C. ditto, in volts	0.82	0.82	0.96	0.90	
20	Voltage at relay ditto, in volts	0.80	0.80	0.88	0.83	
21	Current passing through relay ditto, in milliamperes	99	92	104	100	
22	Current passing into T.C. when T.C., with T. C. short-circuited, is occupied, in milliamperes	122	121	125	121	
23	Train shunt resistance pick-up, in ohms	9.0	8.8	8.9	9.2	
24	Train shunt resistance drop-away, in ohms	4.9	4.9	5.1	5.5	
25	Resistance of T.C. relay, in ohms	9.05	8.97	8.85	8.85	
26	Weight of rails in T.C. section, in lb.	90 BS	90 BS	90 BS	90 BS	90
27	Arc trenails T, or fang bolts F, used	T	T	T	T	
28	Class of ballast and road bed	Ashes.	Ashes.	Ashes	Ashes.	A
29	Number of points and crossings in T.S. section	1 pair points.	1 crossing.	Nil.	1 pair points.	
30	Insulation of T.C. rails, or ballast resistance, in ohms	54	46	62	40	

OTE. — In line 5 where two lengths are given there are two positive rails in parallel, near points.

urrent track circuits. TABLE I. (*Continued.*)

	110	111	112	113	114	115	116
1922. n p. e ain.	April 1922. Down hump. D_1 Fine after rain.	April 1922. Down hump. D_2 Fine after rain.	April 1922. Down hump. E_1 Fine after rain.	April 1922. Down hump. E_2 Fine after rain	April 1922. Down hump. F_1 Fine after rain.	April 1922. Down hump. F_2 Fine after rain.	April 1922. Down hump. F_3 Fine after rain.
	11.6	13.3	18.6	16.6	8.2	19	14.3
	14.2	17.3	25.3	10.3	10.0	16.6	14.3
	110	124	120	138	125	136	50
	122	137	140	150	135	150	65
	100	90	70	100	100	90	100
	75	112	150	85	87	105	86
	121	140	170	124	117	134	119
	...	...	...	...	...	...	...
	...	...	...	...	...	...	...
	4.0	2.6	1.8	3.7	3.8	2.7	3.6
	112	131	160	115	110	112	111
	12.5	12.5	12.5	12.5	12.5	12.5	12.5
	11.2	11.3	11.3	11.2	11.2	11.2	11.3
11	1.05	1.01	1.08	1.05	1.02	1.10	1.04
6	0.88	0.94	0.96	0.91	0.89	0.95	0.97
6 9	0.88 0.80	0.94 0.82	0.96 0.85	0.91 0.81	0.89 0.80	0.95 0.85	0.97 0.80
	100	98	96	99	100	101	96
	121	140	170	124	118	134	119
	9.2	9.0	6.3	8.6	9.8	9.6	9.9
 5 S s.	5.7 8.9 90 BS T Ashes.	4.5 8.85 90 BS T Ashes.	3.1 8.85 90 BS T Ashes	5.2 9.0 90 BS T Ashes.	5.3 8.9 90 BS T Ashes.	5.3 9.0 90 BS T Ashes.	6.7 9.0 90 BS T Ashes.
r s.	1 pair points.	Nil.	1 pair points.	1 crossing.	1 pair points.	1 crossing.	Nil.
	53	23	12	43.6	43.6	26	42

NOTE. — In 27 F = Fang bolts, T = Trenails.

TABLE I. (*Continued.*) Record of t

Test number.	DESCRIPTION OF TEST. Test record No.	129	130	131	132
1	Date of test	April 1922.	April 1922.	April 1922.	April 1922.
2	Locality of track circuit	Down hump.	Down hump.	Down hump.	Down hump.
3	Name of track circuit	M_2	N_1	N_2	N_3
4	State of weather	Fine after rain.	Fine after rain.	Fine after rain.	Fine after rain.
5	Length of track circuit, in yards	25.2 25.5	11.2 11.6	19.6 19.3	70
6	Length of leads relay end, in yards ..	205	185	205	225
7	Length of leads battery end, in yards	230	200	225	250
8	Regulating resistance, in ohms	100	100	100	100
9	Current through T.C. with relay disconnected, in milliamperes	100	55	85	52
10	Current through T.C., relay disconnected but rails short-circuited relay end, in milliamperes	120	120	124	124
11	Voltage across regulating resistance, relay disconnected, in volts	...	..	...	...
12	Ditto with rails, short-circuited relay end, in volts	...	...	...	...
13	Voltage feed end when relay disconnected, in volts	2.1	6.9	4.2	7.4
14	Current to T.C. when relay connected and T.C. complete and clear, in ma.	113	110	113	114
15	Voltage at T.C. supply, bus bar ditto, in volts	12.5	13.0	13.0	13.0
16	Voltage on terminals of regulating resistance, ditto, in volts	11.0	11.2	11.2	11.1
17	Voltage on track side of regulating resistance, in volts	1.20	1 36	1.7	1.43
18	Voltage on rails, feed end of T. C. ditto, in volts	0.85	0.94	0.91	1.0
19	Voltage on rails, relay end of T. C. ditto, in volts	0.85	0.94	0.91	1.0
20	Voltage at relay ditto, in volts	0.70	0.93	0.99	0.96
21	Current passing through relay ditto, in milliamperes	82	117	116	118
22	Current passing into T.C. when T.C., with T. C. short-circuited, is occupied, in milliamperes	120	120	124	124
23	Train shunt resistance pick-up, in ohms	9.9	9.9	9.9	9.7
24	Train shunt resistance drop-away, in ohms	5.8	5.4	5.7	5.6
25	Resistance of T.C. relay, in ohms	8.8	8.9	9.1	8.9
26	Weight of rails in T.C. section, in lb.	90 BS	90 BS	90 BS	90 BS
27	Arc trenails T, or fang bolts F, used	T	T	T	T
28	Class of ballast and road bed	Ashes.	Ashes.	Ashes.	Ashes.
29	Number of points and crossings in T.S. section	1 crossing.	1 pair points.	1 crossing	Nil.
30	Insulation of T.C. rails, or ballast resistance, in ohms	21	125	49	142

NOTE. — In line 5 where two lengths are given there are two positive rails in parallel, near points.

current track circuits. TABLE I. (*Continued.*)

34	135	136	137	138	139	140	141
1922. wn np. 2 ne rain.	April 1922. Down hump. O_3 Fine after rain.	April 1922. Down hump. P_1 Fine after rain.	April 1922. Down hump. P_2 Fine after rain.	April 1922. Down hump. Q_1 Fine after rain.	April 1922. Down hump. Q_2 Fine after rain.	April 1922. Down hump. R_1 Fine after rain.	April 1922. Down hump. R_2 Fine after rain.
.3	14.2	15.83	43.3	11.5	29.6	21.0	31.0
.6		15.2	45.0	13.3	29.3	20.0	31.3
15	230	185	210	230	245	230	255
25	245	205	255	245	275	250	285
90	90	90	70	90	80	90	70
95	77	89	140	64	120	88	140
28	133	136	168	136	150	130	160
..	...	...	...	...	...	...	...
..	...	...	...	...	...	...	...
3	5.1	4.5	2.8	6.6	2.9	3.8	1.7
19	123	125	160	125	140	120	150
.5	12.5	13.0	13.0	13	13	12.5	12.5
9	10.8	11.1	10.8	11.0	11.0	10 8	10.8
29	1.41	1.7	1.9	1.8	1.8	1 39	1.42
98	1.07	0.98	1.04	1.06	0 93	1.02	0.90
98 82	1.07 0.92	0.98 0.95	1.04 1.06	1.06 1.04	0.93 1.0	1.02 0.86	0.90 0.78
95	109	118	124	128	122	101	78
28	133	136	168	136	150	130	160
.9	8.7	9.3	7.7	8.3	8.8	8.9	8.0
.4 05 BS T ies.	4.3 8.95 90 BS T Ashes.	4.7 9.0 90 BS T Ashes.	3.2 9.15 90 BS T Ashes.	4.0 9.2 90 BS T Ashes.	4.4 8.85 90 BS T Ashes.	5.1 8.9 90 BS T Ashes.	2.5 8.94 90 BS T Ashes.
ssing.	Nil.	1 pair points.	Nil.	1 pair points.	1 crossing.	1 pair points.	1 crossing.
14	66	51	20	103	24	43	12

NOTE. — In 27 F = Fang bolts, T = Trenails.

margin of tolerance being allowed in each case. The pick-up and drop-away currents are rather high, but this is principally to provide that the relays will be less liable to the effects of stray currents than if they were more delicately adjusted.

Electrical point detection.

The position of the facing points in all cases is electrically detected. At the hump boxes the Siemens Brothers types are used, and at the signal boxes the « Syx » patterns are fitted.

A typical circuit diagram illustrating point detection is given in figure 6, from which it will be seen that current is taken from the 28-volt positive bus-bar to a contact to, and working with, the left-hand point tongue. Similarly, there is a wire connecting the positive bus-bar to a contact working with the right-hand point tongue. If the left-hand contact is made, a current passes from the positive bus-bar through left-hand contact to left-hand coil on point repeater relay in signal box, and thence to the negative bus-bar. A corresponding current will pass if the right-hand contact is made. If the tongue of the point is more than 3/16 inch from the stock rail the contacts in either case will not be made and the control apparatus will not release the locks, etc.

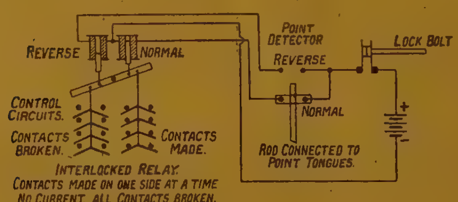


Fig. 6. — Point and bolt detector circuit.

The system adopted to connect the point detector movements with the control apparatus is to provide a double interlocked repeater relay so arranged that only one relay can be operated at a time. Each relay is fitted with the multiple contacts required, generally between three and eight each. The circuits of the electric locks, indicators, electric signals, or any function affected by the points and the controlling lever, are led through the contacts of the point detection relay; therefore, if the points are laying correctly on the left-hand side, the left-hand repeater relay will be energised and the contacts in the control circuits made, with the consequence that current will pass in the control circuit and release the electric lock on lever or light the indicator as previously arranged. If the points were not correctly or quite over, or they lay in the opposite direction, the lever in question would be locked electrically and the signalman could not move it. In cases where a facing-point plunger is fitted the position of the plunger is also electrically detected.

The push-button signal frames.

The signal frames in the hump boxes are of a novel design, being a complete signal frame, track-circuit diagram point detector indicator and signal light and arm repeater all combined. The signal frame is arranged so that the push buttons operating the points, the point detector repeater, the track circuits and signal repeaters are shown on the frame in positions relatively to their geographical positions on the ground. There are two push buttons for each pair of points, one to operate points from right to left and the other from left to right. The white light indicators of the electric point detectors are placed between the two push-buttons of the points they refer to, so that the signalman can see it easily and definitely. The track-circuits also appear on the signal frame in their relative geographical position on the ground by means of the usual sections and a red light representing « section occupied » and green light for section « clear », so that the signalman can follow the move-

ments of the vehicles as they pass over the various points and quickly set the routes for the following vehicles. To ensure speedy working it has been arranged that the space between the nose of the points and the fouling positions shall be divided into two track-circuited sections : 1° the points themselves, and 2° the remainder of the space of the fouling points. The signalman can, and does, watch the track-circuit indicator, and directly the vehicle has passed off the point tongues, as indicated, he reverses the points (if necessary) for the following vehicle. This saves time and allows the vehicles to be shunted with a shorter headway, and obviously is of importance when quick shunting is desired. The two push buttons for each pair of points are inter-connected, so that when one button is down the other must be up. The down positions, with repeater alight, being the operating position desired by the signalman, and the points remain in that position until the opposite push botton is depressed. The motion of the push button is transmitted to the contacts by means of quick-break switches, as the voltage may be 112 or 130 volts. The force required by the

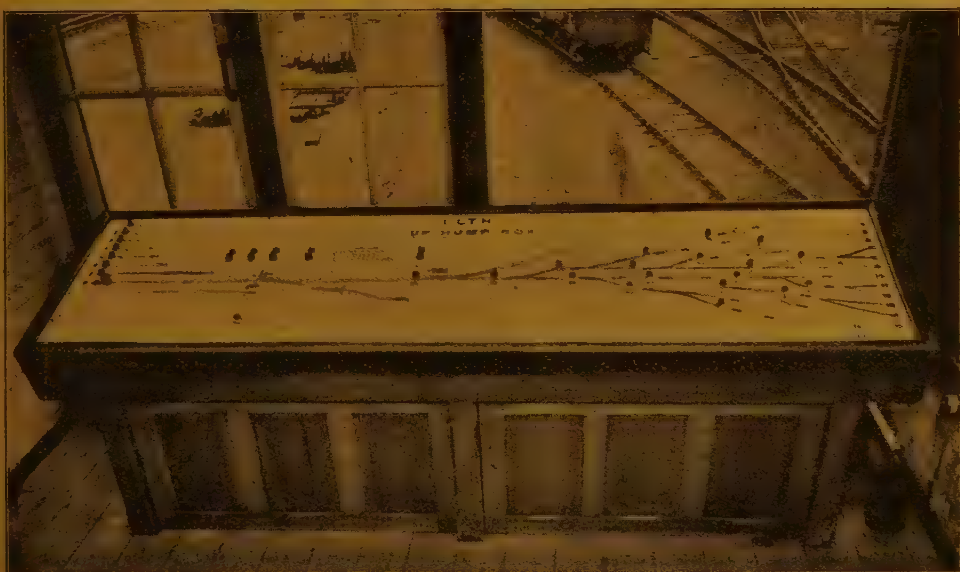


Fig. 7. — View of electric push-button signal frame in up « hump » box.

signalman to depress the buttons is infinitesimal. The signals are similarly shown in their geographical position on the frame, and are operated by two push buttons for the on and off positions of the signal arm. The signal arm repeater gives a red light for on and a green light for off. The track circuits for the reception roads, which are completely track-circuited for their whole length, are shown in their relative geographical position, and indicate to the signalman by the track-circuit indicators red and green lights, on the push-button signal frame, whether the roads are occupied or clear, but in addition to this, in the hump boxes, two push buttons are provided on the signal frame for each re-

ception road track-circuit to enable the signalman in each of the hump boxes to « block » either of the roads against the signalmen at the east or junction boxes, allowing a train to go into that road, as the hump-box signalman may wish to send a train back along that road in the opposite direction to the usual and correct running direction of traffic. The track-circuits on the reception roads are also indicated in the signal boxes at the entrance to the yard in the east and junction boxes. The effect of the signalman in the hump box blocking the track circuit is to operate the track circuit to the occupied position, with the consequence that the signal for that route is locked in the east or junction box, as the case may be, which prevents the signal for that route coming off. A view of the push-button signal frame is given in figure 7.

The working of the electric point and signal movements and the track-circuits have already been described. The small lamps are of 55-volt type, 7/32 inch diameter; they all give white lights, but the red and green coloured lights for track circuit and signal repeater indications are obtained by placing red or green glasses 5/16 inch diameter over the lights in their respective positions. In the case of the white lights for point detector indicators white grained glass is used, as it is found that with clear glass the light is too dazzling for the signalman.

If the shunting operations go awry it is necessary quickly to warn the driver to stop, and later to advise him to commence pushing again. This is done by two electric syrens of the Klaxon horn type, one near the hump and one halfway down the yard. Both the horns sound simultaneously, and are operated by the signalman in the hump box depressing a special push button provided on the signal frame, or by the shunter on the ground by means of a plunger conveniently situated. A code of hoot signals has been arranged.

Replacing signals to danger automatically.

It has been arranged that when a train has passed the signal and entered the next section, on all passenger main running roads, that the train itself shall throw the signal to danger automatically. In the case of electric signals this is done by the action of the train on the track-circuit as it enters upon it, which, as already explained, causes the relay contacts in the control circuit to be disconnected; consequently current ceases in the signal clutch coil and the signal arm goes to danger by gravity. In the cases of mechanically worked signals an electro-magnetic clutch is arranged in the run of the signal wire. The circuit of the electro-magnetic clutch passes through the control apparatus contacts, the track-circuit relay, point detector relays in the same way as for an electrically-worked signal. Should the track-circuited section be occupied, or the point tongues not properly over, the electro-magnetic clutch circuit will be disconnected and the signalman will not be able to pull the signal arm off, but in such circumstances the signal lever would also be locked. Supposing the road to be clear and the signal off, as the engine passes the signal and enters on the next section, the track-circuit would operate and disconnect the clutch circuit, allowing the signal to go to the danger position by gravity; the signalman would afterwards replace his lever to the « on » position, when the electro-magnetic clutch would re-engage. The signal would be similarly replaced to « danger » if a pair of points were moved or reversed, or if for some reason they got out of adjustment. The protection to a following train is therefore fully covered. Both the electrically and mechanically worked signals, if « off », can be replaced to « danger » by the signalman at any time if circumstances call for it. The electro-magnetic clutch in

use at Feltham is of the Syx pattern and a circuit diagram is given in figure 8.

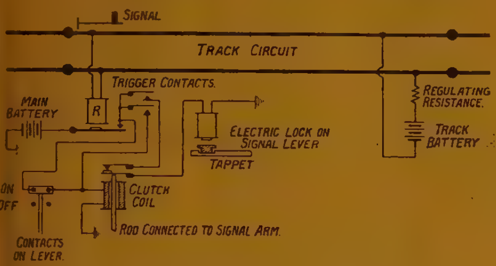


Fig. 8. — Circuit diagram of signal replacer.

The special feature of this replacer is that to ensure the clutch disengaging when the electro-magnet is disengaged a weight is released which knocks the detent out of engagement with the clutch by means of a hammer blow. The resistance of the electro-magnet coils is 150 ohms. They are connected to the 28-volt control circuit supply; a minimum current of 90 milliamperes is required to pick up the weighted hammer and 75 milliamperes to retain it in its position. The contacts on the signal lever for the control circuit is worked by the catch handle on the signal lever, so that the energy is used when the signal is on, but only when the signalman pulls the catch handle immediately before he commences to pull his lever and the lever is in the off position.

Control circuit.

The track-circuits are known as primary circuits, as the trains passing over the sections shunt the current from the track-circuit relays, resulting in breaking down the secondary or control circuits which operate the several junctions, such as signal replacers, signal and point motors. Locks on levers indicate a typical secondary circuit as given in figure 9. Current for all control circuits is taken from the 28-volt supply, each control circuit being taken through a fuse and the through contacts on the point or signal levers, track-circuits point detectors or any other controlling device that affects the signal or function the circuit is arranged for.

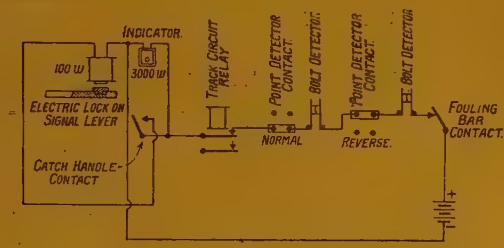


Fig. 9. — Typical secondary or control circuit.

There are 216 control circuits over the whole area, distributed as follows :

Feltham Junction	70
— East	64
— West	8
— up hump. . . .	36
— down hump . .	38
	216

Working during night time and foggy weather.

During the dark hours and when it is foggy it would be difficult for the signalman to see whether the siding points were occupied or clear, also to see the numbers on the wagons telling to which siding the next vehicle is to be shunted, but a powerful electric lamp is fixed on the marshalling side of the signal box, with the beam of light, of suitable diameter, arranged to fall on the part of the wagon where number is chalked, so that as the vehicle passes the signalman distinctly sees the number and acts upon the information. During these times the signalman relies upon the indications of the track-circuit on the geographical push-button frame of the various sections and the point detector indicators as to whether the route he wishes to set is clear and properly set for the vehicle to pass over it. Hence the gravitation

or marshalling yard can be used during the night-time or foggy weather with nearly the same facility as during the day-time.

[628 .154 (.73)]

Types of turntable developed for heavier locomotives.

Figs. 1 to 3, pp. 613 and 615.

(*Engineering News-Record.*)

Cantilever or tipping turntables have been used almost universally in the United States for turning locomotives from the earliest days of railway development. European practice has tended in other directions, preferring continuous or discontinuous (two-span) turntables. The center-bearing tipping table has the advantage of low resistance to turning, permitting hand operation even with fairly heavy locomotives; but this advantage has tended to disappear with the increase in engine weight and length — which now call for turntables 95 to 110 feet long — and the extensive adoption of power tractors to turn the tables. Under these conditions the numerous disadvantages of the tipping turntable have made themselves felt more and more, with the result that in recent years there has been a steady drift toward the adoption of either continuous or two-span construction.

Two very carefully worked out designs have recently been put in service, a continuous table by the American Bridge Company and a twin-span turntable by the Bethlehem Steel Company. They are both designed to overcome the disadvantages of the old type cantilever tables, namely, the large clearance between wheels and circle rail to permit the ends to swing free under full load, and the consequent hammering of the wheels and the circle rail at all points where locomotives move on and off the table, the delay due of the necessity of balancing each locomotive over the center of the table before it is turned, and the requirements for a stiff and consequently deep table to reduce deflection.

With the new tables no time is lost in balancing an engine, the table being swung as soon as all the engine wheels are on its deck. Thus for a given maximum engine wheelbase it is stated that the length of table may be 10 to 15 % less than that of a center-bearing table. In handling dead locomotives with a switch engine of small wheelbase, both engines may be placed on the table, thus avoiding delay.

Continuous turntables. — In the structure of the continuous table the girders are proportioned to give end reaction sufficient to develop ample traction under dead-load and prevent any lifting at the free end under one-sided loading. Lateral strength and stiffness are provided by systems of lower and upper laterals designed for the most unfavorable conditions (full load on one-half span and drive through the motor at the free end only) and are favored by the absence of joints and the continuity of the flanges of the main girders. The bracing system includes struts on the girders to the outer ends of the truck frames to hold the trucks in true posi-

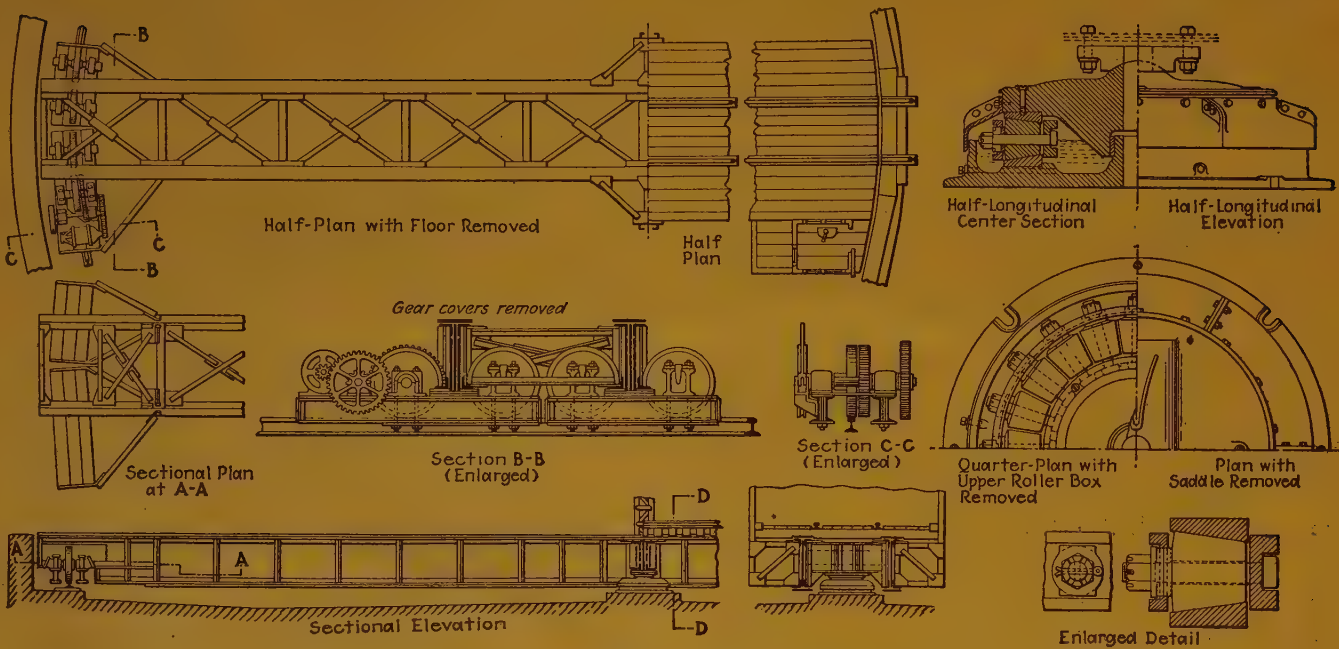


Fig. 1. — Details of a continuous turntable.

tion without diminishing their vertical flexibility.

Flexibility of the trucks to give equal division of load among the several wheels is provided by the use of two equalizers or truck frames, one centered under each of the two main girders. Only the reinforced girder webs bear on these frames, so that the truck frames can rock slightly in the direction of their length; sufficient play is provided under the nuts of the bolts which connect the main and truck girders to allow of this rocking. Railway car journal boxes of the M. C. B. type support the six undriven truck wheels, while the driven wheels, which may be subject to load reversal by the action of the driving gear, have a pedestal bearing. An extension of the truck frame carries an intermediate shaft and the motor, with double gear reduction to the driven truck wheel. The position of the driving machinery on this overhang gives increased adhesion to the driven wheel, which is an advantage when the table is empty.

The table has two driven wheels, at opposite corners, and correspondingly a motor drive on each truck. The two motors are coupled electrically but not mechanically. For usual conditions, induction motors with resistance control are provided. The brake, hand operated, is placed on the intermediate shaft, which position gives greater braking effect than a brake on the axle and avoids the extra load on the motor pinion which would be imposed by a motor shaft brake.

In the construction of the roller bearing center, the essential features are a cylindrical rocker bearing of the turntable on the upper plate, a construction of the two center plates which gives a deep oil reservoir in the lower plate and a strong and stiff upper plate (which must transmit the central load to the roller track), and a roller construction which provides effectively for division of the load and for adjustment. Transmission of lateral forces through the center is taken care of by a bronze-bushed-pintle engagement of the two plates.

The roller tracks (fig. 1) are made of tempered cast steel, while the rollers are forged. The rollers are mounted loosely on pins which engage a stiff inner live ring and hold the rollers against outward movement by bronze washers mounted in an outer live ring and capable of adjustment out or in by a castle nut working on a fine-thread pitch on the pin. The roller assemblage is free of any connection with the pintle, and can adjust itself to symmetrical load distribution. Four anchor bolts hold down the lower center plate. For anchorage against horizontal thrust, four anchor lugs bolted to the lower side of the bottom plate enter recesses in the supporting masonry where they are grouted in position. A sectional hood bolted around the outside of the upper center plate gives access to the roller adjusting nut and protects the bearings against the entrance of dirt.

The first table of this type was put in service by the Wheeling & Lake Erie Railroad at Gambrinus, Ohio, in 1921. This was a 100-foot turntable, doing service for which a 110-foot tipping table had been projected. Several other tables are in operation on this road, on the New York Central, and on the Boston & Maine, and a dozen or more are under construction. An 85-foot table of this type but with roller-bearing truck axles has been constructed for the Central Vermont Railroad. Roller-bearing axles are considered desirable where it is expected that a table may have to be operated by hand at times.

Some figures on power consumption were obtained in a test of a 100-foot table on the New York Central at Suspension Bridge, N. Y., which had been designed for a full rotation in 2 minutes. Measurements made with a table empty and with a 142-ton locomotive both balanced and close to one end showed periods of 1 min. 37 sec. to 1 min. 59 sec. for a full

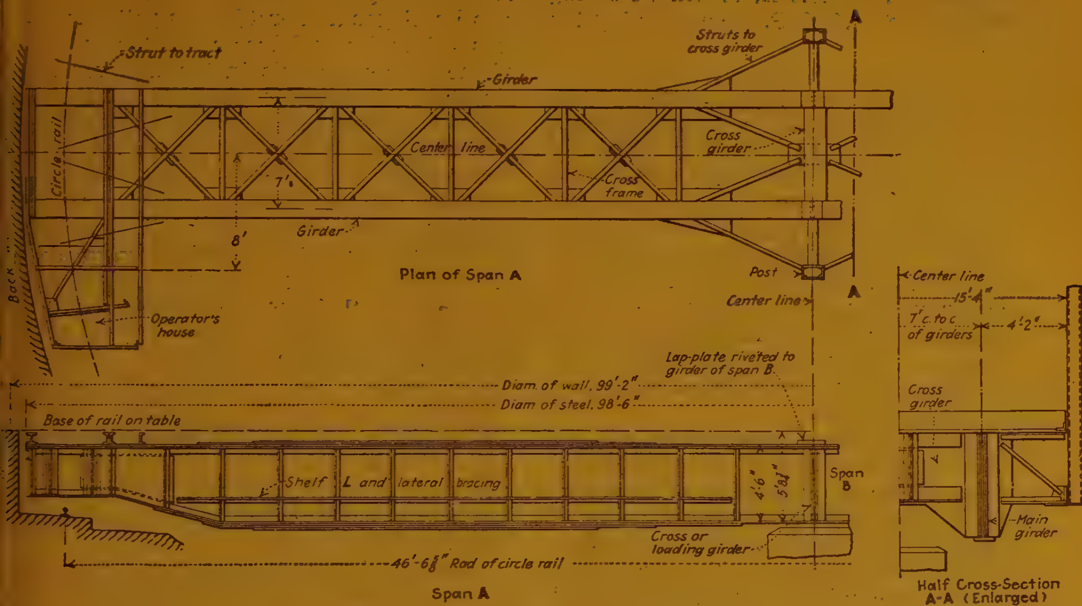


Fig. 2. — Details of twin-span turntable.

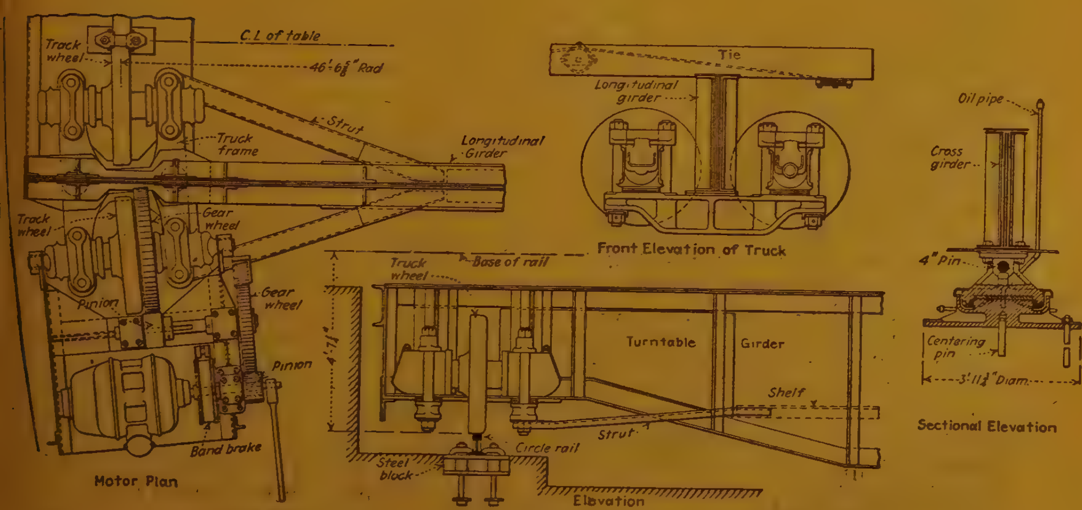


Fig. 3. — Detail of the center and trucks, twin-span table.

rotation, and power consumption ranging from 8.6 to 19.0 H. P. while running and 20.2 to 57.5 H. P. when starting the table.

Twin-span turntables. — The 100-foot non-balancing turntable having a 5-point support, installed on the New York Central Railroad at Corning, N. Y., is an example of the comparatively new twin-span type of turntable. In this design, both live- and dead-load are distributed equally between the circle rail and the center bearing. The table in question is designed for a 450-ton engine in any position and its weight is about 70 tons in working order, including the motors, gearing and wheels.

In the twin-span design the usual pair of full-length girders is replaced by two short girder spans connected to a transverse loading girder which is mounted on the center bearing. The connections of the span to the loading girder are sufficiently flexible to permit of each half of the span of the table deflecting independently and to allow for possible settlement in the center foundation. This flexibility also compensates for irregularities in the surface of the circle rail. Movement at the center hinge is minimized by centralizing it about an axis at approximately mid-depth of the span, at which level the lateral bracing is placed. This bracing is made continuous for the full length of the table as shown in figure 2.

Among the advantages claimed for this type of turntable are lower first cost for the total installation of pit and table, convenience of operation, and lower expense for operation, maintenance, and repair. With two half spans the girder depth and pit depth may be less than for the usual spans, while the use of standard railway car wheels, journal boxes and bearings reduces the cost. Load distribution reduces bearing weight and consequently reduces wear and repairs.

In each span the two plate girders are connected by struts or cross-frames and also by diagonal lateral bracing attached to shelf angles and located at the level of the no-flexure axis in the transverse girder. This bracing serves to connect the two spans as a unit, to transmit power forces from end to end, and to transmit to the center bearing such longitudinal thrust as may result from braking forces or the pull of a dead-engine hauler. It is designed for a transverse shearing force of 25 000 lb. at each end of the table and for a longitudinal force of 200 000 due to braking. Cantilever frames at diagonally opposite corners carry the operating cab and part of the suspended motor platform. At the end opposite the cab, the cantilever frame carries a concrete block equivalent to the weight of the cab, in order to give equal tractive effort at each end.

The dead-engine hauling device mentioned above consists of a drum and cable mounted on the turntable and operated from the motors by means of clutches.

The table has rigid end supports and does not rock or tilt, so that it requires less than the usual width of gap between table and pit wall. As it consists practically of two short simple spans, it can carry overload in the same way as similar bridge spans, and engines may be run over it at considerable speed without damage to the table or its machinery.

A center bearing designed to take the longitudinal thrust due to engine braking is a special feature of the turntable. The bearing is of the flat disc type with a loose phosphor-bronze disc riding freely between polished cast-steel surfaces in an oil chamber which is so trapped that if the pit should be flooted, the oil would remain in place. On the foundation pedestal is anchored a heavy base casting which is formed with an 18-inch pintle, surrounded by an annular groove. Over this pintle fits a casting like an inverted

pan, having the inside of its annular flange faced with a bronze ring which rides against the pintle and thus transmits end thrust to the base casting. The horizontal contact surfaces of the two castings between which rides the phosphor-bronze disc are polished and oil is fed to them through holes in each casting. Owing to the distribution of the load, how ver, the weight carried by the center bearing is relatively light, being given for a specific case as 2 150 lb. per square inch of the bronze disc.

To equalize the load on the disc bearing there is a horizontal 4 1/2 inch pin between the top casting and a shoe bolted to the cross girder. By raising the table just sufficiently to remove its weight from this pin bearing, the shoe pin can be withdrawn and the shoe and top casting then removed to permit inspection or repair of the bearing plate.

Heavy construction of the end trucks is necessary on account of the proportion of the total load transmitted to the circle rail. At each end to the turntable are two two-wheel trucks, each having a cast-steel frame, H-shaped in plan, with two wheels between the side pieces. The girder is trunnioned on the truck frame. Thus the truck, which is placed exactly radial, equalizes the load on the wheels and the wheel bearing on the single circle rail allows the truck to take the deflection of the girder. The wheels are mounted on short axles with bearings in journal boxes from which the truck frame is supported by heavy column bolts passing through loading caps on top of the boxes. No springs are employed, so that the ends of the table are supported rigidly by the circle rail. A pair of diagonal struts is attached to each main girder and to the end of the truck to serve as collision struts. Steel car wheels,36 inches in diameter and having the flange cut away and the thread turned to a cone conforming to the diameter of the circle rail, are used for the trucks. The wheels, journals, bearings and boxes are of M.C.B. standard type.

One of the outer wheels at each end, at diagonally opposite corners, is driven from a 35-H. P. motor through a simple train of gears to a spur wheel keyed on the driven axle, as shown in figure 3. Either motor will turn the table with the heaviest locomotive. The motor and gearing are carried by a structural platform having one end suspended from the driven axle and the other from cantilever beams on the deck of the turntable. The load is so distributed that the two driven wheels carry about 35 and 25 % of the total weight on the trucks with the turntable empty and loaded respectively.

With a heavy engine in position, the turntable can be swung through 360° in 100 seconds with either one or both motors, as the alternating current compels uniform speed. With direct current, the speed depends upon the loading and the number of motors. In operation, only one motor is used as a rule, the other being held in reserve, thus reducing the amount of current required without reducing the speed appreciably, except where direct current is used. Both power units have emergency hand gear attachments, and one is provided with a band or friction brake operated by a foot lever in the cab. No end lock is required, the inertia and journal friction being sufficient to hold the table steady in any position. Current is taken from an overhead wire.

This twin-span turntable was invented by engineers in the employ of the Bethlehem Steel Company, Bethlehem, Pa., which company owns the patents. About twenty turntables of this type are now in service.

[725 .32 (.73)]

Pennsylvania completes new freight station.

Figs. 1 to 3, pp. 619 and 621.

(From the *Railway Age*.)

The Pennsylvania has recently completed a local freight station in Detroit, Mich., which represents a new departure in freight house design in a number of respects and is the most important unit in its project of extension into Detroit from Toledo, Ohio. A few years ago the Pennsylvania was without an entry into Detroit, the nearest point on its line being Toledo, 56 miles south. In contrast to the methods employed and the extremities to which railroads were often driven when entering a city in the days of bitter competition, the Pennsylvania was successful in reaching Detroit, in large measure, by means of trackage rights on other lines on equal terms generally with the owning roads and in building a terminal facility within a half mile of the heart of the city, all at the comparatively moderate outlay of $ 15 000 000.

About 300 acres of land were acquired in Detroit for the location of a terminal freight yard for the exclusive use of the Pennsylvania, and a partial development, consisting of a hump yard with a capacity of about 1 200 cars, with engine facilities, etc., has been constructed.

The new freight house is a two-level structure of concrete, steel, brick and terra cotta, 65 feet wide and 780 feet long, located at the intersection of Third and Larned streets about 200 feet south of the Union passenger station. This leaves room for three pairs of team tracks adjacent to the house and additional space between it for an inbound house if the future traffic should require it, the present building being designed as an outbound unit in the event that the terminal facilities are enlarged.

Contrary to the usual arrangement of multiple type houses, the railroad tracks in the new building are located on the upper level. This is because the house is approached from the elevated viaduct entrance to the Union passenger station. The new terminal facilities are served by a single track lead which divides into two tracks a short distance from the viaduct, one of which descends to the team tracks on a three per cent compensated grade. The other diverges into four tracks, which run the length of the house two on each side, making in all in the house a capacity for 59, 40-foot cars.

Separating these two sets of tracks, which are on 12-foot centers, and car door high, is a 660-foot platform 21 feet wide throughout most of the distance, tapering to six feet where the tracks enter the building. Freight is handled between this floor and the lower level by five automatic elevators operating in brick-lined shafts, each independent of the roof. Four of these elevators have 9-foot by 18-foot platforms of 10 000 lb. capacity, while the fifth has a 9-foot by 30-foot platform of 15 000 lb. capacity. The latter elevator is near the west end of the building, being located at this point for convenience in handling bulky materials. These elevators are located along one side of the platform to accommodate the platform scales on the lower level and to afford ample passageway for trucks along the upper level platform.

The lower or street level floor is the trucking story of the building. This floor is 780 feet long, comprising 560 lineal feet of floor 65 feet in width, immediately below the upper level of the house and an additional 220 feet below the elevated approach to the house, this portion narrowing from 65 feet to a minimum of 10 feet at the rear. On both sides of the house are rows of steel rolling doors, with 37 doors on each side and 1 door at the end. These doors are 16 feet wide and are separated only by the steel columns of the building, thus giving continuous drayage frontage around the building which may be approached either from Third street on the front, Larned street along the side or Sixth street at the rear.

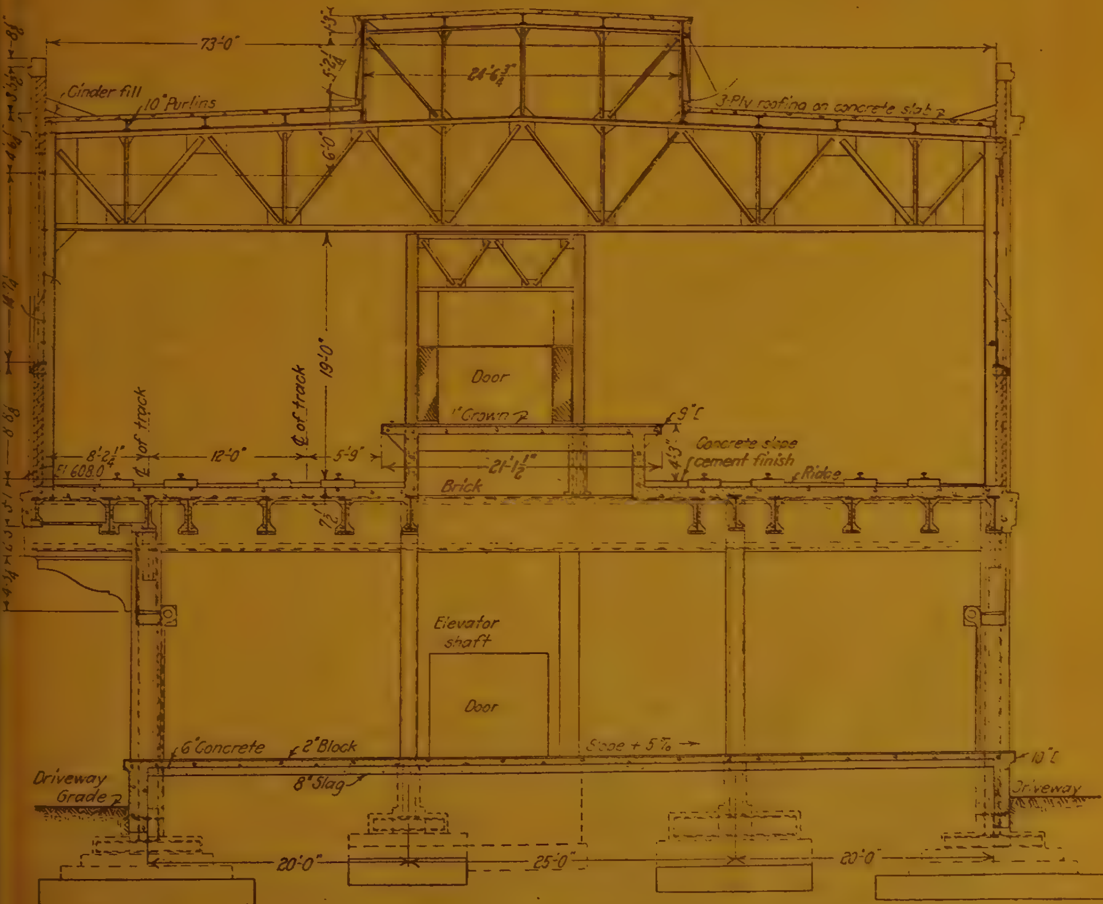


Fig. 1. — A transverse section of the freight house showing typical construction.

Conveniently located on this floor are five platform scales, four of 6 000 lb. capacity and one of 13 000 lb. capacity, all equipped with automatic dials. At the forward end of the house are two large

rooms, one of which is used for the storage of valuable packages and as a charging station for the electric trucks employed in the freight house and the other for the storage of over freight. Each of these rooms is protected by tin clad fire doors. When designing the house it was thought that the need would arise eventually for trolley with which to handle heavy loads between the trucking floor and street vehicles. A runway was therefore installed for this purpose. A unique feature of the house arrangement is the foreman's office, which is situated on a mezzanine floor centrally located. This office is electrically heated and gives the foreman a reasonably clear view of the floor. Fire protection is provided by a fire wall equipped with tin clad fire doors and by hydrants and hose at each elevator.

The floors of the upper and the lower levels are concrete, paved with Kreolite wood blocks to reduce the noise of trucking to a minimum and to make them easy underfoot. Steel sash above each door supplement the open door spaces in daylighting the lower level of the house while the upper level is unusually well lighted by a continuous row of steel sash 10 feet high in each side of the building and by steel sash in a monitor roof 6 feet high and 25 feet wide which extends along the center of the roof. The monitor sash are movable in 60-foot panels to afford ventilation. Electric lighting is provided by two rows of lamps equipped with flood reflectors extending the length of each floor. There are also plugs at intervals along the platform on the upper level for use where it is desired to run extension cords into the cars. As a protection from water the floors are crowned and the area immediately in front of each door is sloped sharply to the outside.

Structurally, the building consists of steel posts and girders, faced with dark rough brick and lined with plain brick with terra cotta inlay and cornice work for architectural effect. The roof is supported on steel trusses and consists of a solid slab of concrete. This slab is covered with 3-ply Johns-Manville roofing and is hidden from view by a 3 1/2 foot parapet wall. All roof flashing and down spouts are copper, the latter being carried down outside of the building but embedded out of sight in the pilasters.

Three expansion joints are provided in the building. These permit free longitudinal movement but are secure against leakage. A further feature of unusual character is the overhang of the upper level of the building on the Larned street side, which amounts to as much as eight feet and which, as shown on the plan, brings the outside rail of the tracks more than a foot beyond the wall of the lower floor. To improve the appearance of the building where the offset occurs, rounded brackets are provided at each post. The load is carried by the steel girders of the building which extend out from the wall of the lower floor.

The elevated approach to the building is a concrete slab carried on concrete-encased girders and posts, protected from weather by Minwax membrane waterproofing covered by a two inch armour coat, the surface being sloped towards drainholes conveniently located. The tracks on the approach are laid in stone ballast except within the house itself, where they are carried on tie plated creosoted wood blocks partially embedded in the concrete. The Pennsylvania's standard concrete bumpers with Westinghouse friction draft gear attachments are installed at the ends of these tracks.

This house is being operated at present with the assistance of two Mercury trucks and 150 trailers and is being used for both in and outbound l. c. l. business. Outbound traffic is being received from one side where a 40-foot concrete driveway is provided along the house, reached from both Third and Sixth streets. Inbound freight is sorted and delivered on

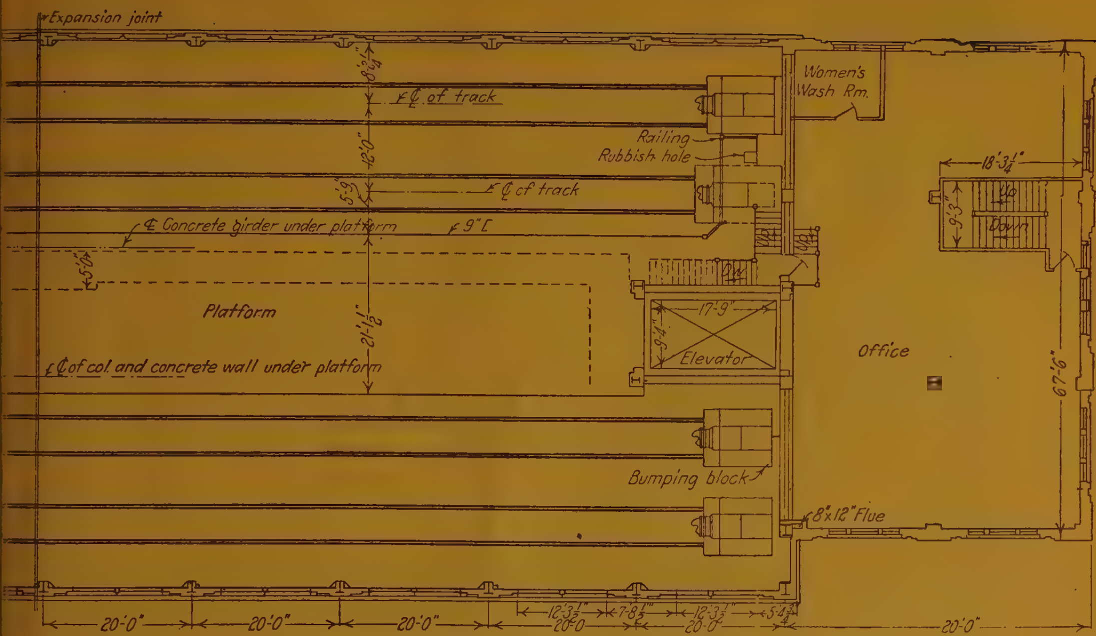


Fig. 2. — A partial plan of the track level.

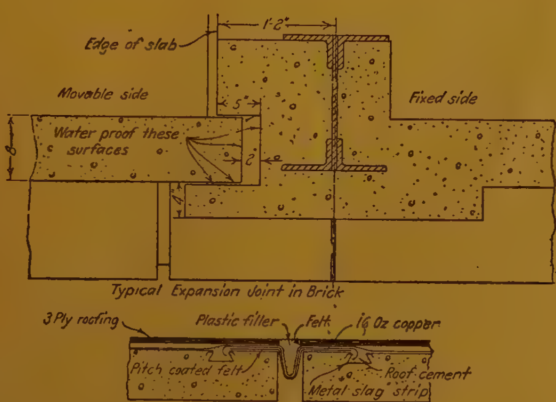


Fig. 3. — Detail of expansion joint in house.

the other side. Freight handlers remain on the floors to which they are assigned, except the tractor operators, who, when occasion demands, haul their loads to destination. On the upper level both sets of tracks are operated simultaneously for inbound and outbound business, the tracks being cleared twice a day and the practice adhered to of loading cars as fast as they are emptied.

The team tracks are six in number, arranged in pairs which are separated by 40-foot concrete driveways, each consisting of a nine-inch slab of plain concrete with a four-inch crown and with expansion joints every 30 feet. These tracks afford capacity for 102 cars.

In addition to these tracks the Pennsylvania has provided team tracks of equal capacity on a 10-acre tract acquired at West Fort and Summit streets, about two miles west of the new terminal and adjacent to the tracks over which the Pennsylvania reaches the new terminal. This development, which is known as Summit street yard, is adapted to expansion to a total of 250 cars and includes an electrically-operated traveling gantry crane installed over two of the team tracks. This crane is of 25 tons capacity and has also a five ton hook for lighter loads. This crane recently made lifts at the rate of 180 in 130 minutes, when loading five large trucks with large water pipe.

[625 .253 (.73) & 656 .253 (.73)]

An unusual idea in automatic train control.

Figs. 1 to 14, pp. 624 to 633.

(*Railway Review.*)

The automatic train control system of the Indiana Equipment Corporation is of the ramp or direct contact type. It was designed and developed by C. F. Shadle, formerly signal and efficiency engineer for the Cincinnati Indianapolis & Western Railroad.

The essential parts of the device consist of a wayside ramp, a contact shoe having a roller contact, a neutral control relay, an electro-pneumatic valve, an automatic air brake valve, and a speed controller. Important features of the system are the provisions to differentiate between permissive and absolute stop and stay signals, selective braking for high and low speeds, the ramp circuit controller, the provision for advance locking of switches, and the fact that the device is made up of standard parts. No special parts are required except the shoe rollers and housing, and certain parts of the speed controller.

The ramp.

The ramp is constructed of standard 4-inches by 5-inches by 1/2-inch angle, with the 5-inch leg turned up. It is 80 feet long and is made up of four 20 foot lengths with an air gap of 3/8 inch between sections. The sections are bonded with slip bond joints. The ramp angle is supported on 13 sawed ties 8 inches by 8 inches by 9 ft. 6 in., which replace the same number of cross ties and permit placing the angle 23 inches or more from gauge side of rail. The angle is set on cast steel

pedestals of sufficient height to bring the contact surface 5 5/8 inches above the top of rail. Standard insulating fibre is placed between the ramp angle and the pedestal and tie plates are required on all ties the full length of the ramp.

The incline both at the receiving and leaving ends changes elevation at the rate of 3/16 inch per foot of length. Both inclined sections are 20 feet in length and the level section 40 feet. The ends are turned down and protected from damage by dragging objects by heavy oak blocks.

The ramps are connected into and are controlled by the existing track circuits and control circuits of the signal system. The contact rollers on the shoe are so designed as to permit a two-inch lateral displacement of the ramp before contact is lost, but a ramp circuit switch is provided to open in case the ramp is moved out of alignment 1/4 inch, either vertically or horizontally, relative to the running rail. This circuit controller is made with four contacts so that it is certain to open the circuit, and transfer the indication to the preceding signal no matter which direction the ramp moves.

The contact shoe.

The contact shoe is located either on the front or rear truck of the locomotive tender, to which it is attached by a bracket especially designed to suit the type of truck in service. The cast steel housing supports and partially encloses two cast steel contact rollers. These rollers have large 3/4-inch corrugations, which ride both edges of the ramp angle. They are so arranged in the housing that the rear roller is 3/8-inch lower than the front one and therefore engages the ramp first. This greatly reduces the shock of contact as the rear roller on making the contact causes compression on the rear spring against the 3-inch hollow stem. The wear on both ramp and roller contact is reduced to a minimum, as the rollers are mounted on non-freeze bronze bushed bearings which insures a rolling and not a sliding contact.

The interior roller frame is suspended by a 3-inch hollow steel tube having 3/8 inch walls. The hollow stem is supported at its upper end by means of a hub bearing and guide. Inside the stem a 20-pound coiled spring is placed to act as a buffer, absorb the shock of contact, and to stop the upward movement of shoe and stem. The weight of the shoe is 65 pounds, and the spring is compressed only one inch when the shoe is down. The rise of the shoe in service is from 3/8 inch to 2 inches, but provision is made for a 3-inch movement in order to give sufficient clearance for any contingency. The guides have 1/4-inch lateral movement to prevent binding of the shoe which is attached to the stem by means of a one-inch steel pin passing through a slotted hole in the shoe housing.

The shoe is suspended by two 1/2-inch steel rods which are designed for safety and to permit adjustment. These rods are provided with and rest on coiled springs to assist in absorbing shock, especially in case the shoe drags through ballast or snow, and to stop the downward movement of the shoe. Just above the rollers there is a heavy horizontal spring in two parts, one in front and one in the rear of the hollow stem to absorb horizontal shock. In service the shoe was a number of times dragged through long stretches of newly unloaded rock ballast without appreciable wear and with no damage either to the shoe or its supporting bracket. In nearly a year's service in a test installation no parts were lost or found loose, no rollers were replaced, and no adjustments made.

At the upper end of the stem is a contact plate, fully insulated, for the pur-

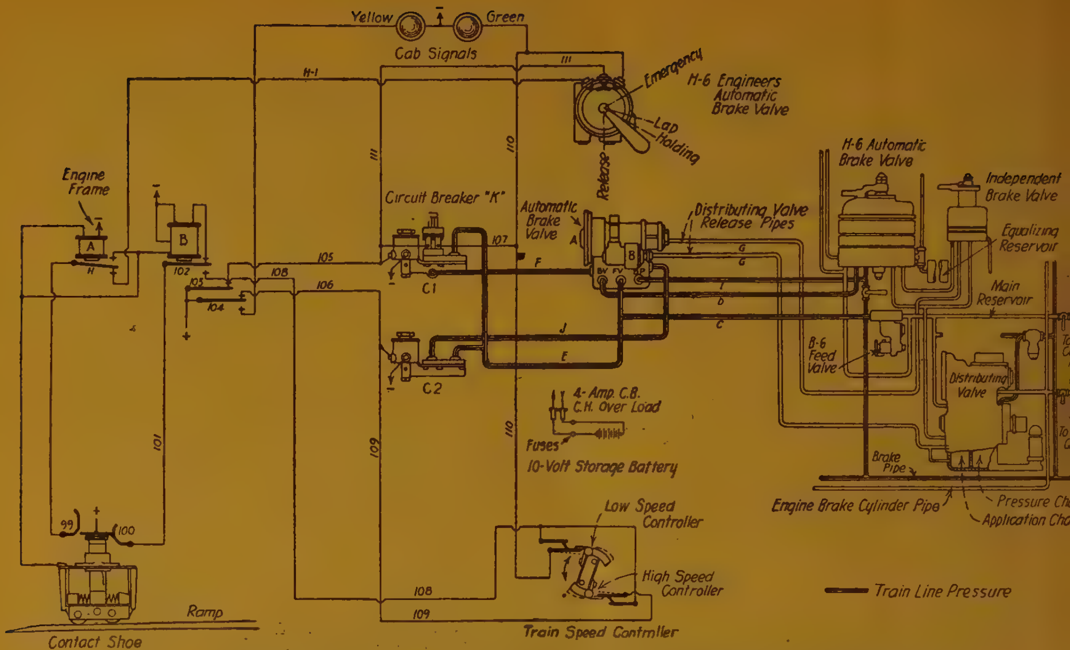


Fig. 1. — Piping and wiring diagram, Indiana equipment corporation automatic train control.

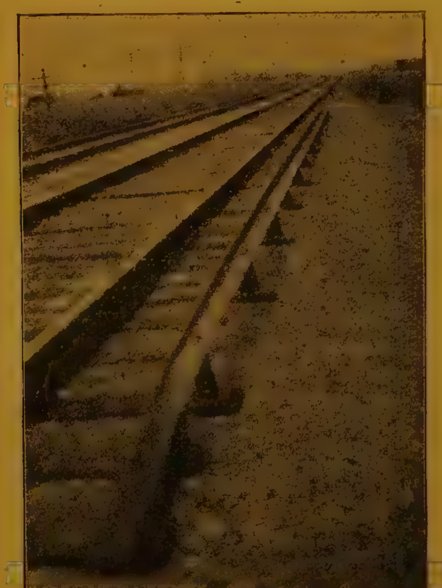


Fig. 2. — Ramp installation, Indiana equipment corporation automatic train control.

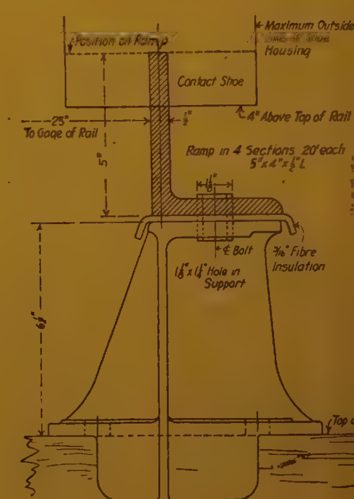


Fig. 3. — Cast steel pedestal suppor
ramp, Indiana equipment corpora
automatic train control.

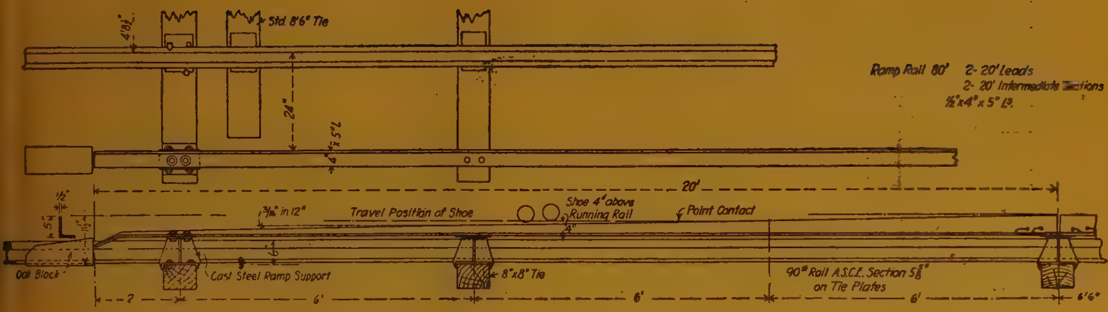


Fig. 4. — Plan and elevation of end section of ramp, Indiana equipment corporation automatic train control.

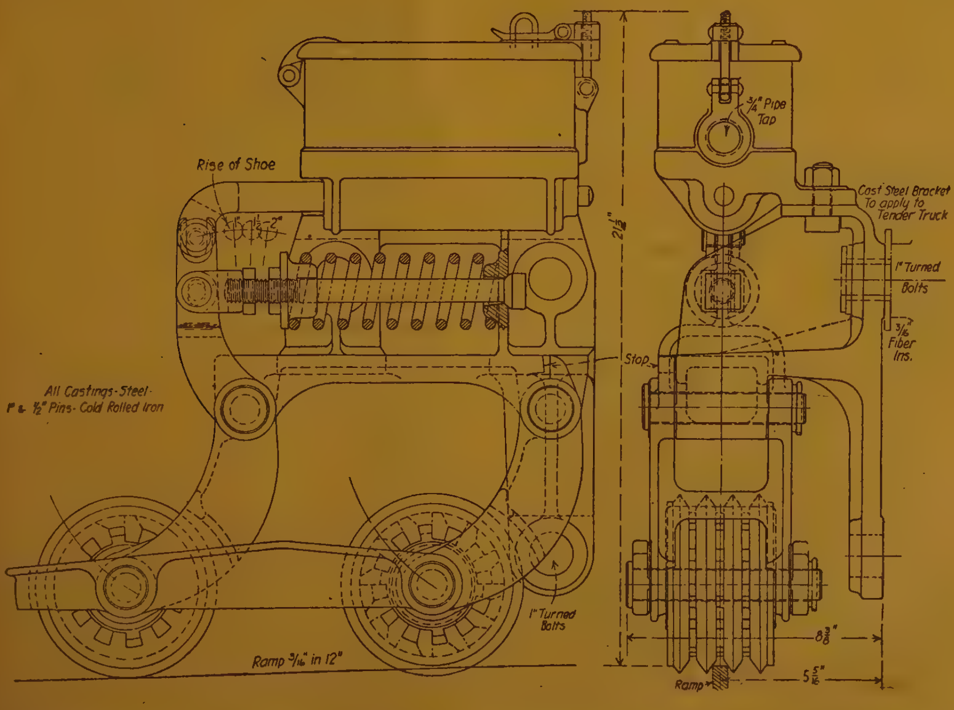


Fig. 5. — Elevations of contact shoe, type B, showing section through upper plunger and circuit breaker.

pose of making and breaking circuits. The wiring is brought from engine control and relay board through Crouse-Hinds condulet and connecting plug.

Since this article was prepared it has occurred to Mr. Shadle that it is undesirable to require a part weighing as much as the shoe does to be lifted and dropped at every ramp. He therefore has worked out an improved design which permits the shoe to remain stationary and only the contact rollers, the frame which supports them and the circuit breaker are movable. This shoe, known as type B, is shown in the figure 5. The frame holding the contact rollers is pivoted above the rollers and extends upward above the pivot point as an arm to which are attached two plungers. The lower plunger is equipped with a stiff coil spring to absorb the shock of contact and to hold the contact rollers lightly against the ramp. The upper plunger, also equipped with a spring, moves the circuit breaker to make or break the contacts at 99 and 100 as in the earlier type of shoe. Reference to the illustrations will clearly show the action of this device. The contact rollers are fitted with vanes, which causes them to rotate on the Hyatt roller bearings with which they are fitted, while the engine is in motion. They are therefore already turning when they come in contact with the ramp, preventing any tendency to slide at the instant of first contact.

Engine control and relay board.

The engine control and relay board consists of Celeron board, 15 inches by 20 inches, on which is mounted one wall type Hall neutral relay having gauze to graphite contacts, except the pick up points which are graphite to graphite both front and back. A sealed moulded glass cover encloses all parts. A heavy compression spring is applied to the movable contacts to prevent vibration, to hold relay in open relation, to prevent wear of contacts by vibration, and to insure quick release of all movable contacts when relay is de-energized. This relay, which is the only one in the system, is similar to the selective type, but is made up of two separate and independent contact movements. One section (A) is the pick up and indicating section; the other (B) is the brake control section. The contacts are in multiple to insure good contact and reduce resistance.

The control circuits leave the board through a specially designed polarized plug and receptacle. This is done so that in case of trouble it is not necessary to attempt repairs with the possibility of improper connections for the engine circuits. All that is necessary is to remove the board from the cast iron housing in which it is secured, and substitute another for it. As the new board cannot be applied unless the plug is placed in its proper receptacle there is no possibility of improper connections being made.

Magnet valves.

The Westinghouse magnet valves used in the H. L. switch control are adapted to the most severe service conditions, and require infrequent repairs or renewals. This type of valve was selected after severe tests, and experience had shown it to be most suitable for the peculiar conditions which obtain in locomotive service. The air ports are larger than those in the commonly used signal magnet valve and the speed of pick up and release is greater. The armatures are separate from the valve stem and both can be quickly and easily removed and replaced. The magnet winding can be removed and replaced without removing the valve body. Due to the improved construction of stem and armature these parts do not wear from vibration as is the case with the signal type of magnet valve when applied on a locomotive. Furthermore there is no trouble

experienced from sticking, or foreign matter reaching the valve stem or armature as the top is sealed. Oil or grit which may reach the valve readily passes out through the two large exhaust ports.

Fig. 6. — Contact shoe, type A, as installed in service, Indiana equipment corporation automatic train control.

The valve (C1), shown in the diagram of the engine circuits and piping (figure 1), is complete with a movement of one inch as used on the H. L. equipment. The valve (C2), also shown in the diagram, does not have either air cylinder or circuit breaker. The air ports in these valves are larger than those of the signal type and the pick up and release action is much quicker. The two valves are mounted side by side in a metal box under seal to prevent their being tampered with. The figure 10 shows the construction and mechanism of valve (C1). Valve (C2) is a duplicate of (C1) except it does not have the air cylinder and circuit breaker.

Automatic brake valve.

The object of this valve is to accomplish a gradual reduction of train line pressure and the valve is equipped with a differential piston which insures a brake application regardless of the train line pressure. The air equipment of this train control system is designed so as to be in parallel with the E. T. or other type of brake equipment on the engine, and in action produces the same effect as a *properly* made hand operation through the engineman's brake valve. When the required brake pipe reduction has been made the valve moves to lap position to hold the brakes until released in the usual manner by the engineman. The valve does not in any manner prevent the engineman from operating the brakes in the ordinary way nor does it take the control of the train out of his hands. Should he make a slight service application the automatic valve completes the operation. Should the engineman fail to obey a signal indication the automatic valve makes a service brake application, but does not prevent him from making a further reduction, or an emergency application, should he choose to do so. He can also move his brake valve to hold position and recharge the train line without interference from the automatic brake valve.

As will be noted by reference to the illustration, the valve is designed along lines which are similar to the construction of the triple valve. It is necessary that it be manufactured of the same high grade materials and with the same precision of workmanship as all air brake control valves.

The valve as it is illustrated is shown in charging or running position. In this position it is set up for high speed running, and to maintain train pressure in the brake system. Feed valve air pressure from the (B6) feed valve to the engineman's automatic brake valve, for the purpose of maintaining air pressure

in the train line and equalizing reservoir, is admitted through port (C) and passes to the engineman's automatic valve through port (D). In this position ports (GG) are in communication; (I), the port leading to the brake-pipe, and (H), the exhaust port to check valve (6) sec. (C-D) are lapped. The feed valve maintains the air pressure in chambers (A) and (B) through the pipes (E), (F) and (J), while the pipes (G), (G) act as an air relief or exhaust

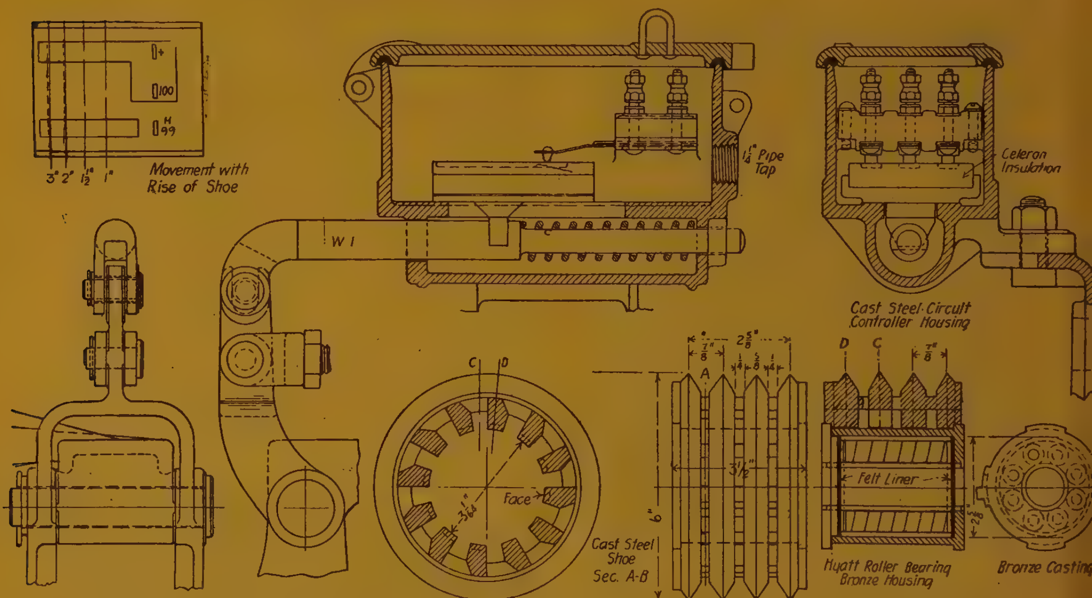


Fig. 7. — Detail of contact shoe, type B, showing plungers, roller contact and frame.

to atmosphere for any air leakage into the application chamber of the distributing valve. It will be seen that the pressures in chambers (A) and (N) are equal, and because of the greater area of chamber (A) the piston (4) will be maintained in the position shown, so long as there is no reduction in the pressure in chamber (A).

The U-pipe connection.

It will be noted that the distributing valve release pipe is looped through the automatic brake and communicates with it when in running position. This connection is necessary when the distributing valve has a U-pipe connection applied between the application chamber of the distributing valve and the release pipe. In case the U-pipe connection is not applied the pipe taps (G) (G) are plugged. Many railroads now make this U-pipe connection for the purpose of relieving the application chamber when the engineer's valve is in running position. The reason is that leakage causes a drop in the brake pipe pressure which permits sufficient travel of the equalizing piston in the distributing valve to cause the pressure to build up in the driver brake cylinders. This results in a pressure between the brake shoes and the driving wheels. The braking effect is so slight as not to be noticeable on

the gauge, but it frequently causes a heating of the tires sufficient to produce enough expansion to cause loose tires and in some cases the throwing of the tires. The U-pipe as applied leads this leakage through the release pipe to the engineer's valve, and exhausts it to atmosphere when the valve is in running position.

Keeping this in mind, it will be noted that it is necessary to lap the ports (G) (G) in the automatic brake valve

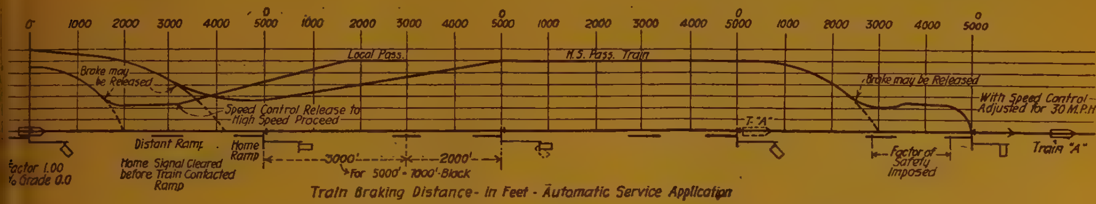


Fig. 8. — Braking diagram, showing arrangement of distant and home ramps, Indiana equipment corporation automatic train control.

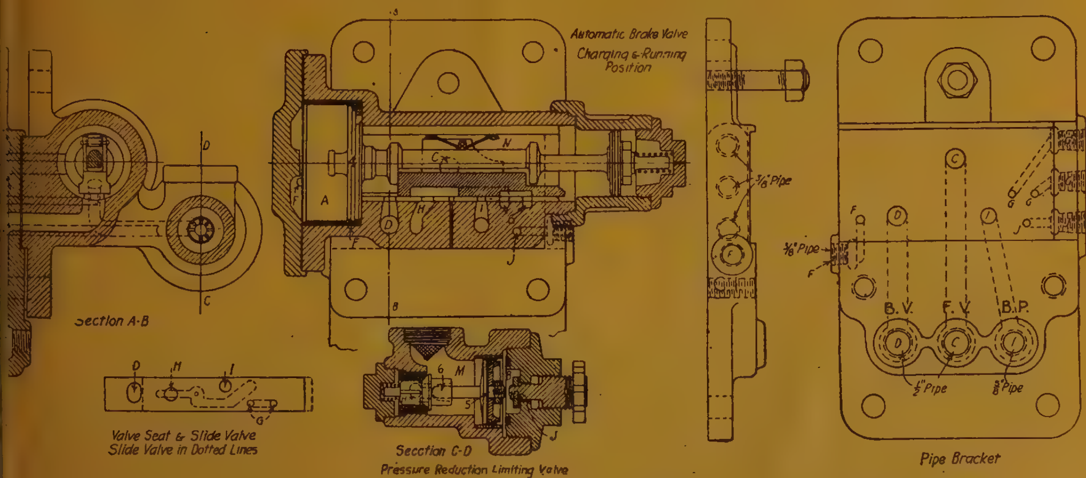


Fig. 9. — Automatic brake valve in charging and running position, also pressure limiting valve.

in order to apply the brakes on the locomotive automatically with the train brakes when the engineer's valve is in running position, otherwise the locomotive brakes will not apply, as the air pressure from the application chamber would exhaust through the U-pipe to atmosphere when the automatic brake valve moves into brake application position.

The automatic brake valve is provided with two ports for brake pipe reduction. One gives a direct connection to the brake pipe; the other is from the brake pipe through the feed pipe connection to the engineer's automatic valve when it is in service or emergency position. A cut out cock is placed in the brake pipe connection for testing purposes, and to provide a cut off in case of damage to the train control equipment enroute, of such a nature as to make it

inoperative. However, should the locomotive leave the terminal with the brake pipe connection cut out, the automatic brake would function through the feed pipe, as no cut out cock is installed in the feed pipe, between the feed pipe valve and the engineer's automatic brake valve. When double heading the second engine is cut out in the usual manner by means of the double heading cock.

Pressure reduction limiting valve.

The purpose of this valve is to slow up the rate of reduction of the pressure and to cause a surge of the air in the train line, when a brake application is made. The limiting valve is quite similar in its design and action to that used in the distributing valve of the E. T. brake equipment. An air expansion chamber (M) has been added as well as two adjustment nuts which permit positive adjustment. These modifications slow up the pop action and give a slow start and stop of the exhaust. The fundamental idea back of this device is that by causing an intermittent flow of the exhaust in the first few instants, succeeding the movement of the valve to cause a brake application, the rush of the air to the exhaust ports will be stopped and a surge created which will be immediately felt throughout the entire train line. The result of this surge of the air is two fold, the brakes apply more nearly at the same time throughout the length of the train, and the brake application is made smoothly without jar to the train or bucking action. The effect of a 25-pound train line reduction is transmitted to the rear of a 100-car train in about 25 seconds instead of three to 3 1/2 minutes in the ordinary braking operation and the brakes apply on the last car in about 55 seconds. Furthermore there is no jar or shock perceptible at the rear of the train from such application.

The rate of reduction of the train line pressure depends on the adjustment made by means of a hand operated wheel which controls the travel of piston (5). Whatever the adjustment, at the start of the brake pipe reduction for either high or low speed braking the exhaust is gradual and intermittent. The slow release of piston (5) compels an exhaust first through the choke or restricted port in check valve, after which the check valve comes to full opening slowly.

The automatic brake valve is under control of electro-pneumatic valve (C1), both for maintaining the running and charging position, and for the brake application position. The release of magnet valve (C2) alone will not cause a brake application. The release of this valve simultaneously with (C1) gives a much quicker service application.

Speed controller.

The speed controller is housed in a steel casting and is preferably located on the end of the axle of the pony truck wheel. The speed controller can be adjusted to any speed, and while it is not sensitive it is very positive in its action. Tests have shown that the arms which operate the switches do not begin to move until the speed reaches the limit for which they are set when they make the full movement necessary to open the switches. Conversely they remain in the outer position until the speed has been reduced to the predetermined limit. The reason for this action is that the weight on the outer end of the arm lies inside of the center line of the pin around which the arm rotates.

Release or holding circuit switch on engineer's automatic brake valve.

The purpose of this switch is to enable the engineer to release brakes, after passing a ramp indicating caution or stop, as soon as the speed has been reduced to the predetermined limit. It also per-

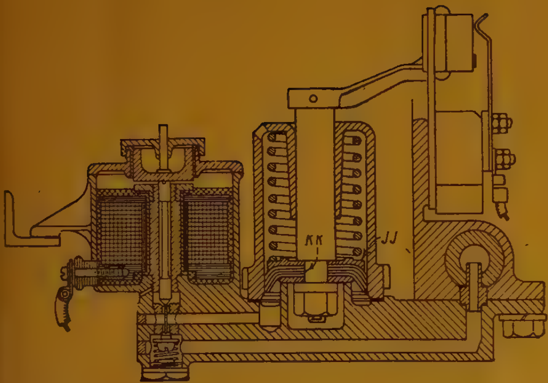


Fig. 10. — Section of electric-pneumatic valve, C_1, Indiana equipment corporation automatic train control.

Fig. 11. — Train speed controller, Indiana equipment corporation automatic train control.

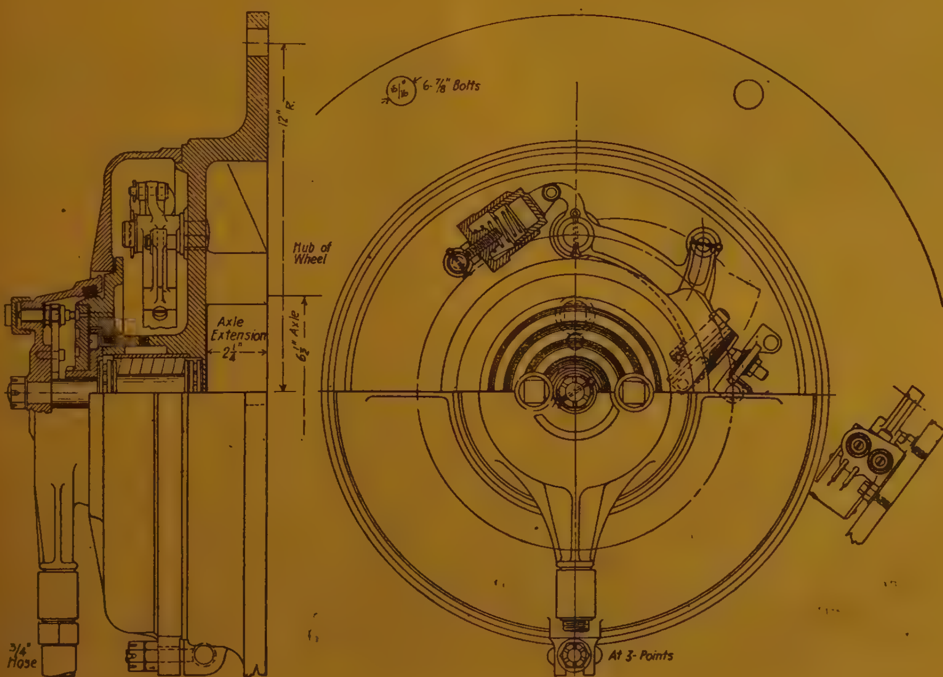


Fig. 12. — Train speed controller, showing closed position. Dotted lines show open position.

mits him to pass over a de-energized ramp, provided he is within the predetermined speed limit. To take advantage of this feature he must move the valve to holding or lap position. It is not possible to use the release position for holding over a de-energized ramp as the braking system would then be overcharged.

Absolute stop and stay signals.

This feature of the device, which is positive in its action, and which tests have proved is reliable, makes it impossible for a train to pass an absolute stop and stay signal. An advance ramp is located at braking distance from the signal, and will bring the train down to low speed. Should an attempt be made to pass the home ramp while the signal indicates stop, a quick action service application, which is out of the control of the engineer, will follow. Should it be necessary to have a train pass over such a ramp this can be done at slow speed, but it is necessary that the fireman hold a circuit controller, which is part of the ramp, in open relation during the time the shoe is in contact with the ramp. At the same time the engineman must hold the engineer's automatic brake valve in holding or lap position. Where this device is installed it will be possible to do away with derails at interlocking plants, in which case the same protection to the cross line is provided as with derails.

Continuous mutual track and train control.

All switches are provided with switch and lock movement, with an electric lock similar to those used on remote controlled switches. This lock is controlled from the first or second block in advance, as desired, by the entrance of the train in the block. Advance locking may also be provided at interlocking plants and telegraph block signals. If necessary to open a switch which is so locked the trainman must go to a cabin and release the lock by means of a time release. This will prevent careless or thoughtless opening of a switch in the face of an incoming train. The time release is so adjusted that if started after a train has passed the advance ramp it does not return before the train has had time to reach the switch. If started before the train reaches the ramp a stop indication will be received, and the train stopped before the switch is reached.

Operation

As previously mentioned, but one relay is used in this system. This relay however is divided into two sections each having an independent magnet. The maintaining clear full speed circuit is energized through relay switches (103) and (104) from the positive battery to conductors (105) and (106) which connect magnet valve (C1) of the low speed brake control and magnet (C2) of the high speed brake control to common battery. The maintaining relay (B) stick circuit is energized from positive battery through circuit breaker (100) on shoe, conductor (101) and switch (102) to common battery through relay magnet coil.

When the shoe contacts with an energized ramp at a clear signal the circuit is closed through (99) and section (A) of the relay picks up and closes circuit to (B) which picks up and closes the circuit through (103) and (105) to magnet (C1) in the electro pneumatic valve. The circuit is completed through the circuit breaker (K) and conductors (107) and (110) which lights the green light to indicate clear. At the same time the circuit is closed through relay switch (104) conductor (106) and the winding of magnet (C2) to common battery. It will be noted when the shoe rises, on contact with a ramp, that contact is made at circuit breaker (99) be-

fore contact is broken at (100), and conversely as the shoe rolls off the ramp contact is made at (100) before it is broken at (99).

Effect of a caution signal

When the signal indicates caution the ramp is de-energized, no electric current the back contact (104) of relay (B).

If the speed of the train exceeds the predetermined low speed, the low speed control arm in speed controller is in open position, and circuit (110), (107) and circuit breaker (K) as well as the electro-pneumatic valve magnet (C1) are de-energized and release the air pressure maintaining valve which drops and shuts off the supply through pipe (E). At the same time pipe (F) is vented, thereby reducing the pressure in chamber (A) of the automatic brake valve. This reduced pressure also releases the cylinder operating circuit breaker (K) which opens circuit (170).

ig. 13. — Engine control and relay board, showing cover opened, Indiana equipment corporation automatic train control.

Fig. 14. — Relay box-locked, Indiana equipment corporation automatic train control.

The complete exhaustion of pressure in chamber (A) permits the pressure in chamber (N) (train line pressure) to force piston (4) to the left. This movement of the piston shifts the slide valve with it, lapping the ports (GG), which cuts off communication through is transmitted to the shoe, and the pick up (A) section of the relay remains in open circuit. The (B) section is de-energized, opens and remains in open relation, and the maintaining brake circuit is transferred to the speed controller. The green light is extinguished and the yellow lamp is lighted through

the distributing valve release pipe. Port (1) communicates with ports (H) and (D) through the slot in the slide valve and exhausts the brake pipe through (H) into chamber (M) of the limiting valve. (H) vents to adjustable chokes through check valve (6). The first expansion of the exhausting air is in chamber (M) and also into small expansion chamber (M1), thence to atmosphere through a pressure limiting device which is not shown in the illustration.

The air pressure in chamber (N) through (C) holds piston (4) to the left, which is brake application and holding position, as the feed valve pressure is blanked off in chamber (N) by the slide valve which connects (D) and (1) but blanks (D) off from chamber (N). The piston will remain in this position until the low speed limit has been reached, when, if the engineer is prepared to do so, he may release the brakes, recharge the train line and proceed within the speed limit by operating the engineer's valve in the usual manner. However, if the speed is increased to exceed the limit the low speed controller will again open and a second application result. This condition continues until a clear ramp is reached when the control is returned to relay (B) and the system is set up for full speed.

If a de-energized ramp is passed at full speed the maintaining circuit is broken at (100) and as both high and low speed control circuits are open both magnet valves (C1) and (C2) will be thrown into open circuits and a quick service application will result. When only magnet (C1) is in open circuit a more moderate application of the brakes is made as the reduction of pressure in the train line is slower.

If the train, moving within the speed limit, passes over a de-energized ramp and the engineer holds the engineer's valve in holding or lap position the circuit is completed through (99), (H), the back point of relay, (A) and conductor (H-1), through engineer's valve switch, conductor (111) and magnetic valves (C1) and (C2). As soon as the ramp is passed the control is again transferred to the speed controller as relay (B) is de-energized and will remain so until a clear ramp is reached.

Tests.

A test installation of this device has been in service on the Cleveland Cincinnati Chicago & St. Louis Ry. at Avon, Ind., about 10 miles out of Indianapolis. Both Mikado and Pacific types of locomotives were equipped. In the tests with the Pacific locomotive speeds varying from 35 to 75 miles per hour were attained at the time the ramp was passed. The train consisted of six passenger cars weighing a total of 637 tons. At the speed of 35 miles per hour and with a reduction of 25 pounds the train was stopped in 1 820 feet in 30 seconds. At the 75-mile speed and the same air reduction the train stopped in 6 630 feet in one minute 30 seconds. In both these cases the throttle remained wide open and the brakes were not applied on the engine. In both cases only the low speed brake action was permitted. The train was moving down grade.

In other tests the throttle was eased off and the engine brakes applied automatically with the train brakes. At 68 miles per hour, with a 25 pound air reduction the train was stopped in 4 030 feet in one minute four seconds.

With a Mikado engine, double heading on a train of 101 cars, the brake action was surprisingly smooth and no jar or buckling action of the train could be observed. Brake pipe reductions of from 8 to 25 pounds were made in 15 to 25 seconds and the brake was applied on the rear of the train in 55 seconds. This test was also made on a descending grade; the total weight of the train was 4 300 tons; the brakes on three cars were cut out so that only 97 cars were ef-

fective for braking. Later a standing test showed a reduction in the train line of seven pounds per minute from a pressure of 50 pounds.

[656. 223.2 (.42)]

Increasing the mobility of freight rolling-stock.

Figs. 1 to 5, pp. 639 to 651.

(From *The Railway Gazette.*)

One of the most difficult problems in connection with the working of railway freight traffic is that of ensuring the maximum user of wagon stock. The difficulty is not, of course, appreciable when trade slackness reduces the amount of railway traffic offering, but in times of heavy loadings the necessity arises for the most effective methods of distribution and control to be exercised. At any time, however, best results can only be secured under a scheme of intensive supervision, as empty wagon movement cannot be eliminated and must therefore be kept constantly under review. Apart from special demands, the rolling-stock problem will, indeed, always be difficult, because certain localities will continue to « make » more empties than they can profitably utilise, and others will always be short of their requirements if they have to rely solely upon the vehicles they « make » for their own use.

In the past, three obstacles have interfered with the arrangement of a more efficient system of rolling-stock distribution, and while to-day, under the London & North Eastern scheme, with which this article is specifically concerned, two have been swept away, there still remains the great obstacle presented by the existence of such a large number of privately-owned wagons. It is considered by many experienced railwaymen that a great opportunity was lost when the provisions of the Railways Bill, with regard to the acquisition of the private owners' wagons, were not carried out. Be that as it may, these wagons, over which the railway companies can exercise no jurisdiction beyond a certain point, involve by their very existence many operating disadvantages and consequent expense that would be eradicated entirely if all wagons were railway owned.

Difficulties in the past.

The two obstacles swept away are : 1° the lack of fully delegated responsibility — down to the individual station — with regard to the control and distribution of stock, and 2° the tendency on the part of station-masters, goods agents and others to requisition more stock than was really required for the traffic on hand or in sight. There can be little doubt that in pre-war days the importance of the railway wagon was not appreciated adequately. Traders regarded wagons more as « warehouses on wheels » than as a medium of conveyance, and it is futile to deny that in those days the railway departments responsible were for certain obvious reasons not too insistent in their demands for rapid clearance. For this and other reasons it was not unusual for station-masters and goods stations to form an exaggerated estimate as to their rolling-stock requirements, and while in times of light traffic this did not present any difficulty, it was far otherwise when traffic was heavy. Even in the former case, the supply of

stock unnecessarily ordered obviously involved a certain amount of unremunerative haulage.

The rolling-stock departments operating in pre-grouping days, with the limitations imposed upon them by conditions, worked on a highly efficient basis, but they were greatly handicapped by incomplete telephonic facilities. They were also hampered to some extent by the lack of unity in rolling-stock matters. All those who have had experience in rolling-stock work recognise that the problem of equating demand and supply is a difficult one. The rolling-stock controller is blamed at once for any shortage in times of heavy pressure, while at periods of light traffic he is constantly being urged to remove wagons not required. Under the new conditions or, at any rate, under those obtaining on the London & North Eastern system, the freight rolling-stock Controller, through the medium of the excellent telephone system, has the advantage of being able at any time to ascertain the precise position in each of the 24 superintendents' districts. This enables him readily to make adjustments, based upon accurate knowledge as to the conditions, that would be impossible if he had not this reliable means of ascertaining the demands and the sources of supply. The organisation is outlined later, but it may here be remarked that the wagon control offices, as shown on the map in figure 3, are the pivotal points of the scheme. Each wagon control office attends to the requirements of specified stations, and each district superintendent's office, which reports direct to the central control, covers specified wagon control offices.

Distribution methods in pre-grouping days.

The constituent companies, whose systems now form part of the London & North Eastern Railway, adopted fundamentally different schemes in connection with rolling-stock control and distribution. On the Great Central and Great Northern Railways, separate departments were in charge of rolling-stock; on the Great Eastern and Great North of Scotland Railways, sections of the Commercial Superintendents' or Goods Managers' offices attended to the work, while on the North British and North Eastern Railways, sections of the operating superintendent's or general superintendent's offices attended to rolling-stock requirements.

For purposes of reference and to explain the preceding paragraph more clearly, it may be advisable at this point to tabulate the practice of the separate companies with regard to rolling-stock control and distribution.

Class of stock.	Controlled by
Great Central Railway :	
Coaching stock, fish vans, goods brakes	Superintendent of the line.
Locomotive coal wagons	Stores superintendent.
Refrigerator vans	District traffic manager.
All other stock	Rolling-stock controller.
Great Northern Railway :	
Main line corridor stock	Superintendent of the line.
Refrigerator cars.	London goods agent.
Locomotive coal wagons and wagons for collieries placed at his disposal by the rolling-stock controller	Mineral manager.
Ropes	Goods manager.
High capacity brick wagons	Goods agent (Fletton).
All other stock	Rolling-stock controller.

Class of stock.	Controlled by
North British Railway :	
Coaching stock, goods and mineral wagons	Operating superintendent.
Sheets and ropes	Goods manager.
Great Eastern Railway :	
Coaching stock and fish vans	Superintendent of operation (A).
Goods brakes, also fitted covered vans during fruit season.	Superintendent of operation (B).
Locomotive coal wagons	Chief mechanical engineer.
All other stock	Commercial superintendent.
Great North of Scotland Railway :	
Goods and cattle wagons, sheets and ropes	Goods manager.
Locomotive coal wagons	Stores superintendent
Passenger stock, fish vans and goods brakes	Superintendent.
North Eastern Railway :	
All coaching stock, goods and mineral wagons, including locomotive coal wagons, goods brakes, sheets and ropes	General superintendent.

It will be seen from this list that there was a wide diversity of practice between the companies in regard to their methods. Obviously, such divergent methods could not be continued under any scheme of unified working, and this was recognised long before the actual amalgamation took place. As early as October 1921, a meeting of rolling-stock controllers' and of goods managers' representatives of the Eastern Group companies was held to consider the possibility of improving the working by the introduction of a system of centralised control. The result was that two men, one from the North Eastern Railway and the other from the Great Central, were delegated to conduct an inquiry on all parts of the system.

Advantages of centralising responsibility for rolling-stock work.

The report on this inquiry was presented in May 1922, and stated *inter alia* that, in order to achieve best results, similar methods must be followed throughout the group. The report added that the principal advantages attendant on the concentration of responsibility for the control and distribution of wagons were as follows :

1° All other things being equal, a fair share of suitable wagons would be supplied against every demand, irrespective of geographical considerations;

2° Uniformity of effort would be directed to the working and turnover of stock;

3° A more flexible wagon supply to meet seasonal demands would be assured;

4° Concentration of stock required for specific traffics would be possible;

5° Increase in the mobility of wagons with a consequent increase in the use of stock should result;

6° Saving of empty wagon-miles;

7° Saving of shunting power in marshalling yards and at stations should ensue;

8° Reduction in the supervisory, clerical and number-taking expenditure should result;

9° A smaller capital expenditure in wagon stock should be involved.

A meeting of the Goods Managers and Superintendents of the Eastern Group companies in June 1922, considered this report, and it was unanimously recommended that a scheme of centralised wagon control should be introduced. A minute was also agreed that any arran-

gements which enabled the total stock owned by the Eastern Group to be controlled and distributed by a central authority, and which co-ordinated all efforts in the general interest, must have a great advantage over the system of many different controls. It was also recommended that the responsibility for the control, distribution and use of stock should be delegated to the operating department, and it was laid down that rolling-stock should be divided into two sections only for distribution purposes, *viz.:*

1° Coaching stock, including horse boxes, hounds vans, prize cattle vans, milk and parcel vans and carriage trucks;

2° All other stock not used exclusively for passenger traffic service, including refrigerator vans, fish vans, goods brakes, also sheets and ropes, excepting only engineers' wagons.

Thus it was decided that the actual control and distribution of goods and mineral train plant should not be associated with the control of purely coaching stock.

Inauguration of central control.

The central wagon control office at York was brought into operation on 7 May 1923, and on the first of that month Mr. C. M. Jenkin Jones, freight rolling-stock Controller (and also now superintendent of the North Eastern Area) London & North Eastern Railway, issued a circular advising all concerned that, on and from 7 May 1923, all goods and mineral wagons, sheets and ropes lettered G. C., G. E., G. N., G. N. of S., H. & B., N. B. or N. E., would be treated as the common stock of the London & North Eastern Railway Company, and be available for indiscriminate use, subject to the instructions contained in pamphlets issued to those concerned. In the circular it was explained that it was essential for everything possible to be done to obtain the maximum use out of the available rolling-stock, as any appreciable improvement could only come through the combined efforts of those engaged in the handling of wagons, sheets and ropes. The circular proceeded to point out that as anything done to increase the movement and the average load of wagons would augment the available supply of empty wagons, it was essential that all concerned should give constant attention to the following points :

« 1° Watch every wagon;

« 2° Keep wagons moving;

« 3° If you cannot keep wagons moving tell someone who can;

« 4° Deal as promptly with empty as with loaded wagons;

« 5° Avoid delay to wagons at stations, yards, sidings and works;

« 6° See no delay occurs in advising arrival of wagons and confirming advices. This may be done verbally, by messenger, or telephone, or by telegraph or post. Send a second advice if no response within 24 hours;

« 7° Increase average wagon load;

« 8° Increase average miles travelled daily;

« 9° *Improve distribution by furnishing accurate wagon reports;*

« 10° Co-operate unselfishly in carrying out instructions;

« 11° Call immediate attention to delay to wagons in the possession of other departments. »

It should here be emphasised, as will subsequently be explained, that the central wagon control office was not established to handle all the distribution arrangements, but merely to control them in the interests of the working of the line as a whole. It was accordingly necessary to arrange for localised supervision to deal with the distribution in the various areas, and it is largely upon the efficiency of the arrangements made by the District Superintendents and their wagon control offices, together with adequate transportation facilities, that

the successful operation of the scheme depends.

Central wagon control office.

The central wagon control office is located on the third floor of the general offices at York, and is arranged as shown in the diagram given in figure 1. As will be seen, the special vehicle section is at one end of the room, while the distribution of wagons in the Southern area,

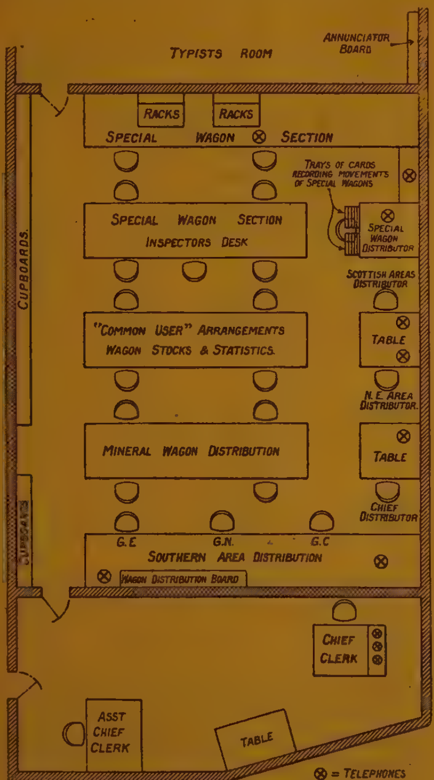


Fig. 1. — General arrangements of central wagon control office at York.

which is divided into the three sections G. C., G. N. and G. E., is conducted from the other. The North Eastern and Scottish areas are located as indicated. All the correspondence relating to rolling-stock matters is concentrated on one desk, the actual distributors being left free to carry out their responsible duties. Altogether the central wagon control office staff numbers 26. The ordinary hours worked are from 10 to 6, but two men work late each evening to cover needs, these men taking duty from 2 p. m. to 9.30 p. m. In addition to the staff indicated above, there are nine female clerks engaged in the traffic statistics office in collating figures in connection with rolling-stock control and distribution, and reference will subsequently be made to some of these statistics. The telephonic facilities in operation are indicated in figure 2.

Fig. 2. — Telephone circuits in operation.

Classification of freight rolling-stock.

In a further circular issued on 3 May, the different types of wagons in general use on the London & North Eastern Railway were classified as shown below, and it was explained that the code word applicable to each class of wagon should be used in all telegraphic or telephonic messages.

COMMON USER WAGONS AND NON-COMMON USER WAGONS LETTERED
G.C., G.E., G.N., H. & B., N.E., N.B. or G.N. of S.

	Code word.	Description.
Open :		
Low sides.	LOW . . .	Sides 2 feet or less (other than plate).
High sides	HIGH . . .	Sides over 2 feet (other than sleep).
Brake or pipe fitted	OFIT . . .	Fitted with automatic brake or pipe (other than fish).
Sleeper	SLEEP . .	High sides with through top planks.
Plate	PLATE . .	Long low-sided wagons with drop sides full length. Most of these are lettered « For plates ».
Covered :		
Ordinary	COVAN . .	Ordinary unfitted covered wagons up to 12 tons.
Ordinary	TRAVAN .	Ordinary unfitted 15-ton covered wagons up to 12 tons.
Brake or pipe fitted	COVFIT. .	Covered wagons up to 12 tons fitted with automatic brake or pipe, except fish.
Brake or pipe fitted	TRAFIT .	15-ton covered wagons fitted with automatic brake or pipe.
Fruit	FRUIT . .	Covered ventilated wagons lettered « Fruit ».
Perishable and meat	PERISH .	Covered ventilated wagons lettered « Meat or Perishable ».
Insulated	INS	Covered wagons lettered « Insulated ».
Refrigerator	REFRIG .	Covered wagons painted white and lettered « Refrigerator ».
Bolster :		
Single.	SINGLE. .	Fitted with one radial bolster.
Twin	TWIN. . .	Twin coupled with radial bolsters.
Double	DOUBLE .	Fitted with two fixed bolsters.
Fish :		
Open and covered.	FISH . . .	Lettered « Fish ».
Cattle :		
Ordinary, clean.	MEX . . .	Unfitted.
Brake or pipe fitted.	MEXFIT .	Fitted with automatic brake or pipe.
Dirty	MEXDY. .	Fitted or unfitted which require cleansing.

The scheme in essentials.

The scheme eventually adopted — and the one now successfully working on the London & North Eastern Railway may be indicated under six heads :

1° Public notices to be posted requesting traders to order wagons not later than 12 noon on the day before they are required for loading;

2° Wagon report to be made out at noon each day by every station to a wagon control office showing inward loaded wagons on hand, empty wagons required for next day's loading, available and wanted, additional or spare;

3° A similar daily report to be submitted not later than 2.30 p. m. from the wagon control office to the district Superintendent;

4° Similar daily report from the district superintendent to be sent to the central control office not later than 3.30 p. m.;

5° Issue of necessary instructions from the central control office to be given not later than 6 p. m.;

6° As a check upon the number of wagons ordered by stations and the use made of wagons received, a daily return from the stations to the central control to be furnished showing wagons forwarded, received and on hand.

Table 1. — **Daily wagon report rendered by stations.**

2/9500 — 1,000,000 — 29/3/23 339/133.

LONDON AND NORTH EASTERN RAILWAY.

DAILY WAGON REPORT.

No. of Message ....

.... *Station.*

PREFIX W.R. CODE TIME. NO. OF WORDS. DATE. 192

Station and Inst., to,	Time Sent.	Clerk's Initials.	Station and Inst., from	Time Received.	Clerk's Initials.

From .... *To* ....

COMMON USER WAGONS AND LONDON & NORTH EASTERN NON-COMMON USER WAGONS.	CODE WORD.	Number of Inward Loaded Wagons on hand. L	EMPTY WAGONS. Required for Outward Loading to-morrow. R	Available for Outward Loading to-morrow. A	Wanted additional. W	To Spare. S	REMARKS (CODE RS), INCLUDING COMING EVENTS.
OPEN.							
LOW SIDES (2 ft. or less)..................	LOW						
HIGH SIDES (over 2 ft.)...................	HIGH						
BRAKE OR PIPE FITTED	OFIT						
SLEEPER..	SLEEP						
PLATE	PLATE						
COVERED.							
ORDINARY (12 tons and under).........	COVAN						
DO. (15 tons)............................	TRAVAN						
BRAKE OR PIPE FITTED (12 tons and under)...............	COVFIT						
DO. (15 tons)..................	TRAFIT						
FRUIT..	FRUIT						
PERISHABLE AND MEAT	PERISH						
INSULATED	INS						
REFRIGERATOR	REFRIG						
BOLSTER							
SINGLE	SINGLE						
TWIN	TWIN						
DOUBLE..	DOUBLE						
CATTLE.							
ORDINARY CLEAN	MEX						
BRAKE OR PIPE FITTED..................	MEXFIT						
DIRTY..	MEXDY						
FISH.	FISH						
FOREIGN NON COMMON USER WAGONS.							
SHEETS	SHEETS						
ROPES	ROPES						

SEE REMARKS ON BACK HEREOF.

As the work had been entrusted to the operating department, it was obvious that the necessary localised supervision could best be achieved through the district superintendents, and accordingly a special rolling-stock section was established in each of the 24 district offices. Even this did not carry down the organisation as far as was necessary, as it was considered a matter of most urgent importance to have the wagon position at the various stations constantly under scrutiny. To attain this end wagon control offices, somewhat on the lines of the old North British, North Eastern and Great Eastern schemes, were introduced at 120 convenient stations, these being responsible for the stock position in specified areas and also for correlating and synchronising the information supplied by the stations. From this it will be seen that there is a clear chain of communication from the individual station to the central wagon control office — the station reports to the wagon control office, which carries on the information to the district superintendent's control section, and the latter in its turn, after summarising the information and making necessary adjustments, reports to the central wagon control office at York.

The district offices and the wagon control offices are as shown below, the numbers agreeing with those indicated on the map in figure 3.

Returns and their compilation.

As in all schemes of rolling-stock control and distribution, the station or other loading point is the natural unit of control, and in the preparation of the London & North Eastern Railway scheme emphasis was laid upon the importance of having a comprehensive yet simple system of returns advancing step by step from the stations. It was also necessary to ensure uniformity of method, and with this end in view pamphlets containing instructions relating to the control and distribution of rolling-stock were supplied to the stations, to the wagon control offices and to the district superintendent's offices. These indicated the steps to be taken at each stage, the pamphlet for use at stations detailing the general instructions relating to the distribution and use of wagons, sheets and ropes. It also contained instructions relating to the distribution of specially constructed wagons — and mineral wagons, with which we are not at present concerned — and concluded with a list showing the allocation of districts and wagon control offices.

The real basis of the distribution is the daily wagon report, copy of which is reproduced in table 1. This, it will be noted, has the prefix « W. R. » and it may be added that the control wagon report and the superintendent's wagon report, to both of which reference will subsequently be made, are similar to the daily wagon report, except that they bear the prefixes C. W. R. and S. W. R. respectively. On the reverse side of the daily wagon report, it is explained that the report must be sent by telephone, telegraph or other means to reach the wagon control office or district superintendent concerned not later than 1 p. m. each day, and that any class of wagon required or available, not specifically provided for in the report (excluding specially constructed and mineral wagons) should be inserted in the spaces provided. Where specific types of a particular class of wagon are required, it is necessary that this should be shown, *e. g.*, in the case of low wagons, if drop sides are wanted, this must be indicated in the « Remarks » column, or, in the case of « Mexfit » wagons, if vacuum brake wagons are required, this must be shown.

Towards the bottom of the form is a section headed « Foreign non common user wagons », and, where it is not possible to load such wagons to or via the owning line, or, as far as possible in the homeward direction, any such wagons

Table 2. — **List of district offices and wagon control offices.**

Section or area.	District officers responsible for distribution of wagons, sheets and ropes.	Wagon control offices.	Wagon control number
Great Eastern	Divisional superintendent, Stratford.	D. S. O. Stratford	1
		St. Margarets	2
		Wickford	3
	Divisional superintendent, Norwich Thorpe.	D. S. O. Norwich Thorpe	4
		Lowestoft Central	6
	Divisional superintendent, Cambridge.	D. S. O. Cambridge	7
		Whitemoor	8
		Whittlesea	9
		March	10
		King's Lynn Town	11
		Downham	12
		Bishops Stortford	13
		Ely	14
	Divisional superintendent, Ipswich.	D. S. O. Ipswich	15
		Wickham Market	16
		Bury St. Edmunds	17
		Haughley	18
		Maldon East	19
		Kelvedon	20
		Halstead	21
Great Central	District superintendent, Marylebone.	D. S. O. Marylebone	22
		Woodford and Hinton	23
		Leicester Goods	24
	District superintendent, Manchester.	D. S. O. Manchester	25
		Hawarden Bridge	26
		Lowton St. Marys	27
		Penistone	28
		Sheffield	29
		Staveley Town	30
		Annesley	31
	District traffic manager, Doncaster.	D. T. M. O. Doncaster	32
		Frodingham	33
		Broughton Lane	34
		Worksop	35
	District traffic manager, Grimsby.	D. T. M. O. Grimsby	36
		Warsop	38
		Louth	50

TABLE 2. — (*Continued.*)

Section or area.	District officers responsible for distribution of wagons, sheets and ropes.	Wagon control offices.	Wagon control number.
Great Northern.	Divisional superintendent, King's Cross.	D. S. O. King's Cross.	39
		King's Cross Goods	40
		Hatfield	41
		Hitchin	42
		Holme	43
		New England	44
	Divisional superintendent, Grantham.	D. S. O. Grantham	45
		Doncaster	46
		Boston	47
		Sleaford.	48
		Spalding	49
		Lincoln	37
	Divisional superintendent, Nottingham.	D. S. O. Nottingham	51
	Divisional superintendent, Leeds	D. S. O. Leeds (G.N.)	52
North Eastern	District superintendent, Leeds.	Leeds, Wellington Street. . . .	53
		Leeds, Marsh Lane	54
		Starbeck	55
	District superintendent, Hull. .	D. S. O. Hull	56
		Driffield	57
		Goole	58
		Cudworth	59
	District superintendent, York. .	D. S. O. York.	60
		Selby	61
		Malton	62
		Scarborough	63
		Thirsk	64
		Northallerton	65
	District superintendent, Darlington.	Darlington	66
		Bishop Auckland	67
		Barnard Castle	68
		Kirkby Stephen.	69
	District superintendent, Middlesbrough.	D. S. O. Middlesbrough.	70
	District goods and docks Manager, West Hartlepool.	D. G. and D. M. O. West Hartlepool.	71
	District superintendent, Sunderland.	D. S. O. Sunderland.	72

Table 2. — (*Continued.*)

Section or area.	District officers responsible for distribution of wagons, sheets and ropes.	Wagon control offices.	Wagon control number.
North Eastern (*continued*)	Divisional superintendent, Newcastle.	Haeton Junction	73
		Blaydon	74
		Blyth	75
		Hexham	76
		Carlisle	77
		Tweedmouth	78
North British	District operating superintendent, Edinburgh.	D. S. O. Edinburgh	79
		Carlisle (Canal)	80
		Riccarton	81
		Reedsmouth	82
		St. Boswells	83
		Galashiels	84
		Peebles	85
		Leadburn	86
		Hardengreen	87
		Berwick	88
		Dunbar	89
		Longniddry	90
		Ormiston	91
		Ratho	92
	District central office, Coatbridge.	Coatbridge	93
		Polmont	94
		Uphall	95
		Bathgate (Upper)	96
		Westcraigs	97
		Blackston	98
		Rawyards	99
		Bothwell	100
		Cadder	101
		Maryhill	102
		Bowling	103
		Balloch	104
		Stirling (Cowpark)	105
		Crianlarich	106
		Fort William	107
	District operating superintendent, Burntisland.	Burntisland	108
		Perth	109
		Thornton	110
		Anstruther	111
		Townhill Junction	112
		Ladybank	113
		Stirling (Shore Road)	114
		Alloa	115
		Leuchars Junction	116
		Dundee (Tay Bridge)	117
		Arbroath	118
		Montrose	119
Great North of Scotland.	Traffic superintendent Aberdeen.	Traffic superintendent, Aberdeen	120
		Craigellachie	121

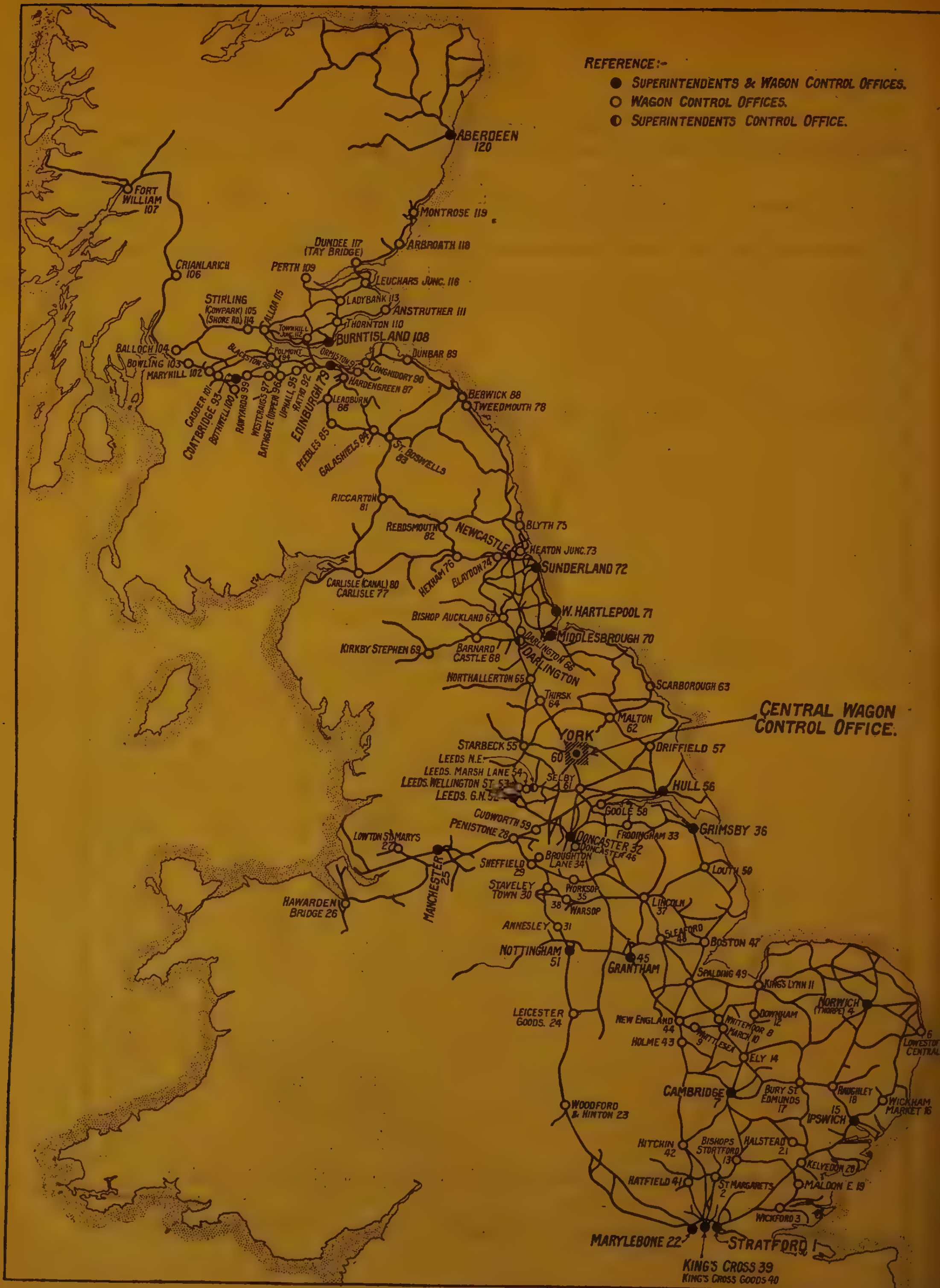


Fig. 3. — Map of London & North Eastern Railway system, showing control points.

LONDON & NORTH EASTERN RAILWAY

(North Eastern Area).

2/99 67 Summary of Daily Wagon Reports received from the undermentioned Stations by the Wagon Control Office at KIRKBY STEPHEN (69), for.............. 192..

STATION	LOW.					HIGH.					OFIT.					SLEEP.				
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.
Penrith																				
Clifton																				
Cliburn																				
Temple Sowerby																				
Kirkby Thore																				
Appleby																				
Warcop																				
Musgrave																				
Kirkby Stephen																				
Tebay																				
Gaisgill																				
Ravenstonedale																				
Smardale																				
Barras																				
Total R. and A.																				
Net W. or S.																				

STATION	PLATE.					COVAN.					TRAVAN.					COVFIT.				
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.
Penrith																				
Clifton																				
Cliburn																				
Temple Sowerby																				
Kirkby Thore																				
Appleby																				
Warcop																				
Musgrave																				
Kirkby Stephen																				
Tebay																				
Gaisgill																				
Ravenstonedale																				
Smardale																				
Barras																				
Total R. and A.																				
Net W. or S.																				

STATION	TRAFIT.					FRUIT.					PERISH.										Remarks
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	
Penrith																					
Clifton																					
Cliburn																					
Temple Sowerby																					
Kirkby Thore																					
Appleby																					
Warcop																					
Musgrave																					
Kirkby Stephen																					
Tebay																					
Gaisgill																					
Ravenstonedale																					
Smardale																					
Barras																					
Total R. and A.																					
Net W. or S.																					

STATION	INS.					REFRIG.					SINGLE.					TWIN.				
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.
Penrith																				
Clifton																				
Cliburn																				
Temple Sowerby																				
Kirkby Thore																				
Appleby																				
Warcop																				
Musgrave																				
Kirkby Stephen																				
Tebay																				
Gaisgill																				
Ravenstonedale																				
Smardale																				
Barras																				
Total R. and A.																				
Net W. or S.																				

STATION	DOUBLE.					MEX.					MEXFIT.					MEXDY.				
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.
Penrith																				
Clifton																				
Cliburn																				
Temple Sowerby																				
Kirkby Thore																				
Appleby																				
Warcop																				
Musgrave																				
Kirkby Stephen																				
Tebay																				
Gaisgill																				
Ravenstonedale																				
Smardale																				
Barras																				
Total R. and A.																				
Net W. or S.																				

STATION	FISH.					SHEETS.					ROPES.										Remarks
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	
Penrith																					
Clifton																					
Cliburn																					
Temple Sowerby																					
Kirkby Thore																					
Appleby																					
Warcop																					
Musgrave																					
Kirkby Stephen																					
Tebay																					
Gaisgill																					
Ravenstonedale																					
Smardale																					
Barras																					
Total R. and A.																					
Net W. or S.																					

TABLE 4. — **Summary of control wagon reports prepared in district Superintendent's offices.**

LONDON & NORTH EASTERN RAILWAY.

(North Eastern Area).

2/9967. Summary of Control Wagon Reports. District Supt's Office at DARLINGTON (66), for........ .... 192......

Wagon Control Office.	LOW.					HIGH.					OFIT.					SLEEP.				
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S	L.	R.	A.	W.	S.
Darlington (66). . .																				
Bp. Auckland No. 1 Sheet (67).																				
Bp. Auckland No. 2 Sheet (67).																				
Barnard Castle (68). . .																				
Kirkby Stephen (69) . .																				
Total R. and A. . .																				
Net W. or S. . . .																				

Wagon Control Office.	PLATE.					COVAN.					TRAVAN.					COVFIT.				
	L.	R.	A.	W.	R.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.
Darlington (66). . .																				
Bp. Auckland No. 1 Sheet (67).																				
Bp. Auckland No. 2 Sheet (67).																				
Barnard Castle (68). . .																				
Kirkby Stephen (69) . .																				
Total R. and A. . .																				
Net W. or S. . . .																				

Wagon Control Office.	TRAFIT.					FRUIT.					PERISH.										Remarks
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	
Darlington (66). . .																					
Bp. Auckland No. 1 Sheet (67).																					
Bp. Auckland No. 2 Sheet (67).																					
Barnard Castle (68). . .																					
Kirkby Stephen (69) . .																					
Total R. and A. . .																					
Net W. or S. . . .																					

Wagon Control Office.	INS.					REFRIG.					SINGLE.					TWIN.				
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.
Darlington (66). . .																				
Bp. Auckland No. 1 Sheet (67).																				
Bp. Auckland No. 2 Sheet (67).																				
Barnard Castle (68). . .																				
Kirkby Stephen (69) . .																				
Total R. and A. .																				
Net W. or S. . . .																				

Wagon Control Office.	DOUBLE.					MEX.					MEXFIT.					MEXDY.				
	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.
Darlington (66). . .																				
Bp. Auckland No. 1 Sheet (67).																				
Bp. Auckland No. 2 Sheet (67).																				
Barnard Castle (68). . .																				
Kirkby Stephen (69) . .																				
Total R. and A. .																				
Net W. or S. . . .																				

Wagon Control Office.	FISH.					SHEETS.					ROPES.										Remarks
	L.	R	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	L.	R.	A.	W.	S.	
Darlington (66). . .																					
Bp. Auckland No. 1 Sheet (67).																					
Bp. Auckland No. 2 Sheet (67).																					
Barnard Castle (68). . .																					
Kirkby Stephen (69) . .																					
Total R. and A. .																					
Net W. or S. . . .																					

Tables 5 and 6 — Summaries of superintendents' wagon reports prepared in central control office.

L. & N E. R. NORTH EASTERN SECTION. **Central wagon control office, York.**

Summary of the Superintendent's Wagon Reports______________192

District.	LOW. R.	A.	W.	S.	Remarks.	COVAN. R.	A.	W.	S.	Remarks.	INS. R.	A.	W.	S.	Remarks.	MEX. R.	A.	W.	S.	Remarks.
N.																				
S.																				
W. H																				
M.																				
D																				
Y.																				
H																				
H. & B.																				
L.																				
Total...																				
	HIGH.					TRAVAN.					REFRIG.					MEXFIT.				
N.																				
S.																				
W. H.																				
M.																				
D.																				
Y																				
H.																				
H. & B																				
L.																				
Total...																				
	OFIT.					COVFIT.					SINGLE.					MEXDY.				
N.																				
S.																				
W H																				
M																				
D.																				
Y.																				

L. & N. E. R. **GREAT EASTERN SECTION.**

Summary of the Superintendent's Wagon Reports______________192

District.	R.	A.	W.	S.	Remarks.	District.	R.	A.	W.	S.	Remarks.
	LOW.						INS.				
B.						B.					
N. T.						N. T.					
C.						C.					
I.						I.					
Total...						Total...					
	HIGH.						REFRIG.				
B.						B.					
N. T.						N. T.					
C.						C.					
I.						I.					
Total...						Total...					
	OFIT.						SINGLE.				
B.						B.					
N. T.						N. T.					
C						C.					
I.						I					
Total...						Total...					
	SLEEP.						TWIN.				
B.						B.					
N. T.						N. T.					
C.						C.					
I.						I.					
Total...						Total...					
	PLATE.						DOUBLE.				
B						B.					
N. T.						N. T.					
C.						C.					
I.						I.					
Total...						Total...					
	COVAN.						MEX.				
B						B.					

available must be inserted in the appropriate columns. Wagons, sheets or ropes on hand that are not required for immediate use must be shown spare on the report, where it is laid down that stock must only be requisitioned or kept on hand for loading traffic which is available for immediate loading.

It will be noted that the columns of the report each bear the code indication. The five columns for figures are headed L., R., A., W., S., respectively, the « Remarks » column is coded « R. S. », and each class of wagon bears its code word as indicated previously. This renders it a simple matter for information to be telegraphed or telephoned, and saves a considerable amount of time that would otherwise be required.

On the receipt of the daily wagon reports from the stations in its area, the wagon control office, after taking any necessary action, prepares a summary similar to that shown in table 3, which refers to Kirkby Stephen. This summary, it will be seen, is merely an analysis of the daily wagon reports, which enables the wagon control office to ascertain for each class of wagon the total required and available, and the number wanted additional or spare. The information from this summary is next passed to the control wagon report, which has to be despatched to reach the district Superintendent not later than 2.30 p. m. each day. The control section of the district superintendent's office, as in the case of the control wagon office, summarises the reports in the form shown in table 4, and, having made what adjustments are necessary, concentrates the resulting information on the superintendent's wagon report, which is due at the central wagon control office not later than 3.30 p. m. each day.

On arriving at the central wagon control office, or on information being received there by telephone, as it generally is, the information is taken by the appropriate sections and transferred to summaries of the superintendent's wagon reports. A part of the North Eastern Area summary is reproduced in table 5, and the Great Eastern summary in table 6. On the completion of these summaries it is possible for the distributors to ascertain precisely the rolling-stock position all over the system, and by consultations with each other, they are able to make adjustments between areas as required. Each section distributor naturally makes adjustments within his area to the best advantage, and, by reason of his familiarity with the work and the flow of traffic, knows fairly well at which points on other areas he may be able to obtain stock or dispose of surplus vehicles. By 6 p. m. or before, each day, orders relating to the distribution are being telephoned to all the district superintendents' offices, these orders subsequently being confirmed by telegram in the manner shown in the example given in table 7. Many instances might be adduced to show the extreme utility of this comprehensive scheme of supervision, but such elaboration would not carry the review any farther. The whole position is this : The information compiled by the various stations is analysed and sifted at the wagon control offices, and on the result, adjustments are made in the wagon control districts. The appropriate form is generally handed to the guard as his authority to move wagons and empties. (See table 11.) The same process is repeated in the district superintendent's office, and eventually, on the basis of the information summarised in the central wagon control office, which portrays the actual stock position all over the system, adjustments are made to meet the fullest requirements in the most economical manner. Between 3.30 and 5 p. m., therefore, it is possible for the freight rolling-stock controller to know precisely the points at which stock is required, and where there is stock available. He is also able, on the basis of the adequate information furnished, to ar-

Fig. 4. — Section of Southern area distribution desk, showing empty wagon flow board.

On completion of distribution arrangements each day, and when subsequent alterations are made, the empty wagon flow board is adjusted, and consequently shows at all times the true position with regard to the orders for empty wagons all over the system.

Fig. 5. — Specially constructed vehicle distribution section, showing nests of trays for holding cards to record movements of vehicles.

range for alternative types of wagons to be supplied where these can fittingly be used. In short, he has a grip upon the position that it would be impossible for him to obtain in the absence of such an effective scheme of recording the movement of stock.

Table 7. — **Telegraphic confirmation of orders and their interpretation.**

TELEGRAM.

URGE SLEEP SALT West Hartlepool OFIT Wrenthorpe COVFIT Doncaster INS REFRIG East Goods Yard London GN COMBINE Darlington TRAFIT BOGIE FISH Grimsby 10 COVERED FISH Berwick balance FISH with all other empties Hull FUSIL.

INTERPRETATION.

Send sleeper and salt wagons West Hartlepool, open fitted Wrenthorpe, covered fitted Doncaster, insulated and refrigerators East Goods Yard, London GN. combine Darlington 15-ton fitted covered and bogie fish Grimsby, 10 other covered fish Berwick, balance fish with all other empties Hull. Clear out all empties from your District to-day certain.

TELEGRAM.

DRAGON OHIO 100 LOW HIGH with SLEEP TRAFIT FISH FRUIT GRIMBSY OFIT Wrenthorpe ON PLATE York 6 COVFIT Norwich balance COVFIT Temple Mills PERISH Elmswell INS REFRIG Victoria Docks TWIN Frodingham SPIDER Nottingham COVANS Cambridge and Kings Cross 20 MEX Lynn Am urging MEX March OHIO 10 Trowse SPIDER Ipswich 100 LOW HIGH Whittlesea 50 Withemoor and Norwich 180 Whitemoor told Bishopsgate to reduce Whittlesea order to 150 and Whitemoor to 100 and to give special attention to latter. The opens ordered Grimsby are required for loading early morning MOSELLE.

INTERPRETATION.

The following are wanted for to-morrow's use. Reply when will be sent. Send on all speed, 100 low or high sided with sleeper, 15 tons covered fitted, fruit fish wagons Grimsby, open fitted wagons Wrenthorpe GN., plate wagons York, 6 covered fitted wagons Norwich, balance covered fitted wagons Temple Mills, perishable wagons Elmswell, insulated and refrigerator wagons Victoria Docks, all twin bolster wagons Frodingham GC. The following told to assist the stations named with the undermentioned..... Nottingham ordinary covered wagons to Cambridge, and Kings Cross 20 cattle wagons to Lynn, I am urging cattle wagons to March; out of these send on all speed 10 cattle wagons to Trowse. Told Ipswich to send 100 low or high sided wagons to Wittlesea and 50 to Whitemoor, and Norwich to send 180 to Whitemoor. Also told Bishopsgate to reduce Whittlesea order to 150 low high and Whitemoor to 100, and to give special attention to latter. The open wagons ordered to Grimsby are required for loading early in the morning. Give matter special attention.

Control and distribution of special wagons.

Supervision over special wagons is exercised from one section of the control room. The head of this section, prior to the change, was in charge of the outside arrangements for special loads in the largest district of the old North Eastern system, and it therefore thoroughly acquainted from practical experience with the various types of wagons.

The control is effected on the basis of special urgent train messages (see table 8) sent in daily from each station, showing specially constructed wagons owned by the London & North Eastern Railway, received, on hand or forwarded. Information from these train messages is entered up on cards, and in table 9 a

TABLE 8. — **Urgent train message used in connection with special wagons.**

T. 419. ,/356. 75,000—25-4-23.

LONDON & NORTH EASTERN RAILWAY.

URGENT TRAIN MESSAGE.

.... *Station.*

No. ....

Return to the Central Wagon Control Office, York, of Specially Constructed Wagons owned by the London and North Eastern Railway received, on hand, or forwarded on the .... **192**.........

Wagon Number.	Company Lettering.	Type of Wagon.	Carrying Capacity. Tons.	Received		Forwarded to Station & Co.	L. or E.	If Loaded.	
				From	Date.			Weight T. C.	Description of Traffic.
1.	2.	3.	4.	5	6.	7.	8.	9.	10.

† Insert your Wagon Control Office number as shewn in Appendix « A » to the General Instructions in regard to the Distribution of wagons, etc.

* When wagons are loaded to foreign stations the route should be shewn in Column 7.

.... *Signature of Agent*

typical card is reproduced showing the method of recording the movements of 20-ton trolley wagon N. E. 78883. The tray system is adopted in connection with the recording of special vehicle movements, two nests of 11 trays (each containing 30 spaces) being available for the ready laying out of cards and so facilitating their identification. In the figure 5 we reproduce a general view of the special wagon section.

As the tray system would be somewhat unwieldy for the recording of information regarding machine wagons, gunpowder vans, quintuples and other vehicles, of which there is a large stock, the cabinet system is adopted for them. These vehicles, within their respective classes, are, of course, interchangeable with each other, and so differ from such vehicles as trolley wagons, which have to be ordered with particulars of dimension. It is, therefore, sufficient to keep particulars of machine wagons and similar classes in numerical order in cabinets divided into sections : on hand, spare; on hand, required; on hand, inward loaded; to arrive, loaded; to arrive, spare.

Terminal wagon user.

An important return compiled in connection with the system of freight rolling-

Table 9. — Typical special vehicle card, recording movements.

3,57 | 1

Trolley **Wagon No.** *N. E. 78883.*

CARRYING CAPACITY } *20* TONS.

Date. *1923.*	From	To	Loaded or Empty.	T.	C.	Remarks.
Oct. 18	*So. Shields.*	*St. Peters.*	*Ld.*			
20	*St. Peters*	*Heaton.*	*E*			
23	*Heaton.*	*So. Shields.*	*E.*			
24		*at " "*	*"*			*W.*
25	*So. Shields*	*Will. Quay.*	*Ld.*			
26	*27*	*at " "*	*"*			
29	*Will. Quay.*	*Carville.*	*E.*			
31	*Carville.*	*Runcorn Dk.*	*Ld.*			
Nov. 3	*Runcorn Dk.*	*Home.*	*E.*			
7	*Leeds.*	*York.*	*E.*			
8	*York.*	*Hull.*	*Ld.*			

stock distribution on the London & North Eastern Railway is entitled « Record of the average terminal user » of all railway-owned or hired wagons used for traffic invoiced through the goods department. This return is a monthly statement compiled in the traffic statistics office and supplied to the central wagon control office on the 20th of the month following that with which the figures are concerned. A daily record is also prepared in the traffic statistics office and this can be obtained by the central wagon control office as required.

Approximately 4 000 points send in cards daily by the first passenger train after 9 a. m., and a copy of one of these cards is reproduced in table 10. On the card all railway-owned or hired wagons used for traffic invoiced through goods

TABLE 10. — **Card forwarded daily by each station regarding terminal wagon user.**

Stock No. 412. 3/101. 1,000,000. 19/4/23.

LONDON & NORTH EASTERN RAILWAY.

TERMINAL WAGON USER RETURN.

Control No. **37** *Terminal Point No.* ....

Daily return of all Railway owned or Hired Wagons on hand, received, and forwarded (loaded or empty), used for traffic invoiced through Goods Department. (See Central Wagon Control Circular No. 1.)

Station or Works, &c. .... *Date* *192*

(1)	Loaded. (2)	Empty. (3)	Total. (4)	Shew here explanation of any delay to wagons.
On hand at 9 a. m. yesterday.				
Received since 9 a. m. yesterday.				
Forwarded since 9 a. m. yesterday.				
On hand at 9 a. m. to-day				

Signature of Agent ....

department are included except the following :

1° Cattle wagons required and used for live-stock;

2° Fish wagons required and used for fish traffic;

3° Service wagons used for the conveyance of company's use traffic or for local haulage purposes.

These cards are summarised by nine female clerks in the traffic statistics office on to daily records (table 12); later, after tabulating the totals by means of mechanical appliances at the end of each month, the monthly record is compiled. A statement for each terminal point in district order is passed down to the central wagon control office for its purpose, together with the monthly summaries in district, section and system order.

These returns are useful as a check upon the handling of the wagons at loading points, and considered over a period, afford an indication as to the points requiring investigation. Since the introduction of this system of returns there has been a steady improvement in the terminal wagon time, which now for the whole line stands at about 1 3/4 days, the Southern area averaging 1.92 days, the Scottish area 1.86 days, and the North Eastern area 1.51 days.

Intensive supervision and its results

The total stock of wagons owned by the London & North Eastern Railway is approximately 300 000, and it will be appreciated that a careful and constant watch has to be kept over the distribution arrangements in order to ensure that the wagons are used to the best advantage of the line as a whole. The methods of accomplishing this have already been reviewed, but it should be added that an important factor is the personal knowledge as to the conditions at various points which the distributors acquire as a result of experience. These distributors, it may be mentioned, have been transferred to York from the areas with

which they are concerned, but in order that they shall acquire familiarity with the work on other sections, they are changed round as circumstances permit. This, again, is an advantage. Not merely are the men cognisant of the situation in the various areas drawn together, and so able to smooth out difficulties as they arise, but by the system of interchange working they are individually widening their experience of rolling-stock work all over the line.

TABLE 11. — **Guard's order to move empty wagons, sheets and ropes.**

T. 44C0. 3/61. 125.000 — 18-4-23.

LONDON & NORTH EASTERN RAILWAY.

.... *Station*, ... *192* .

To the Guard working the .... Train.

You are required to take empty wagons, sheets and ropes as shewn below: —

Description of Stock.	Number.	From	To
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

The casual observer who dropped into the control room about 5 p. m. would indeed be amazed to notice the ease and celerity with which the distributors are able to frame their allocations. He would also be surprised at the noise caused by several men telephoning at once. The telephones in use at the time of our visit were of the ordinary type, but we understand that experiments have recently been conducted with an improved type which will render loud speaking unnecessary. As an example of the ability of the control to make swift adjustments that would have been impossible under the old conditions, reference may be made to a case that came under notice at the time of our visit. The position with regard to such vehicles as fish, refrigerator and insulated wagons is ascertained both morning and evening. On the day in question, Victoria docks reported the morning position in connection with refrigerator wagons as 113 available, 40 required, while Brunswick station and Huskisson dock (both C. L. C. stations) reported 108 and 50 available respectively and none required. This position seemed satisfactory, as several stations have standing orders to send refrigerator wagons to London, and it was computed that these odd wagons would make up the required number. On the evening's position being ascertained, however, it was found that Victoria docks had only 23 refrigator wagons left over and wanted 80 additional. Now, under the old conditions, this heavy demand would probably have resulted in telegrams being sent to all likely points to hasten refrigerator vehicles to Victoria docks, and even if sufficient had been found, it is unlikely that they would have reached the London station in time to meet the requirements owing to their being worked through sectionally. Under the new conditions, however, it became a relatively simple matter to arrange for a special train of refrigerator vehicles to be despatched at once to the point affected. All that the distributor had to do was to ascertain from the evening positions which points had such vehicles to spare. Having found that Brunswick had over 100 vehicles on hand, and no immediate demand for them, it was merely a matter of telephoning a distribution order to the effect that a special train of refrigerator vehicles should immediately be sent to Victoria docks, and within 40 minutes notification was received in the central control office that arrangements had been made for the special to leave Brunswick.

Again, one of the outstanding advantages of the system of central control is the flexibility it imparts to the working. This flexibility is found of great value in many phases of rolling-stock work, but it

proves especially useful in meeting the requirements of seasonal traffics. In the case of herring traffic, for instance, the fleet may, under the stress of weather, have to put into ports other than those originally intended, and it becomes necessary for the rolling-stock controller to divert stock from one point to another at a moment's notice. He is able to do this with facility owing to the concentration of all information in the central control. A central office has the further advantage that it can utilise the resources of the company as a whole, and swing wagons about from place to place to meet the changed needs, in a manner beyond the ability of any sectional or district control.

Table 12. — Record of daily terminal wagon user.

L. & N. E. R. 3/3510. 16,000. 25-7-23.

DAILY RECORD OF WAGONS on hand, received or forwarded with traffic invoiced through Goods Department.

Terminal Point Grimsby Town *No.* 36/20.

Month of Oct. *192* 3

	No. of Wagons RECEIVED previous day.			No. of Wagons FORWARDED previous day.			No. of Wagons ON HAND to-day.			Days User.	
	L.	E.	T.	L.	E.	T.	L.	E.	T.		
1	90	16	106	93	5	98	137	103	240	2.4.	
2	88	23	111	114	24	138	94	119	213	1.5.	
3	153	8	161	131	4	135	139	100	239	1.8.	
4	111	20	131	114	22	136	132	102	234	1.7.	
5	112	25	137	113	26	139	135	97	232	1.7.	
6	138	25	153	122	4	126	138	121	259	2.1.	
7	S										
8	114	25	139	106	41	147	162	89	251	1.7.	
9	113	30	143	126	35	161	133	100	233	1.4.	
10	136	20	156	129	38	167	125	97	222	1.3	
11	140	27	167	121	24	145	131	113	244	1.7	
12	98	25	123	126	33	159	93	115	208	1.3.	
13	131	27	158	105	35	140	126	100	226	1.6.	
14	S										
15											

Another outstanding feature of the scheme is that from the records collated by the traffic statistics office, it is possible for the rolling-stock controller to

check the number of wagons actually forwarded to those demanded. As all rolling-stock men know, this is a matter of the utmost importance. In the past it often happened that more wagons were ordered than were really required, and this frequently led in times of stress to an artificial wagon shortage. Under the new central control scheme of the London & North Eastern, for the whole of the system for the week ending 3 November 1923, the percentage of wagons forwarded to those demanded was 94, the Southern, North Eastern and Scottish areas' percentages being 95, 94 and 93 respectively. In elaboration of this it may be added that 100 008 wagons were demanded from stations in the Southern Area, and 94 676 were actually forwarded loaded. Similar figures for the North-Eastern Area were 65 745 and 61 711, while the Scottish Area figures were 40 276 and 37 540. In all, therefore, the whole of the loading points on the London & North Eastern system during the week ending 3 November 1923, demanded 206 029 wagons and actually loaded away 193 927, this being 94 % wagons forwarded to supplied.

Many further instances could be adduced to show the extreme efficacy of the London & North Eastern scheme of central wagon control. This review is, however, self-explanatory, and from the very simplicity of the methods described it will be obvious that, if those concerned keenly co-operate with each other, the scheme is bound to be a success.

MISCELLANEOUS INFORMATION

[621 .13 (09.3 (.42)]

1. — Locomotives exhibited at Wembley by the London & North Eastern Railway.

The locomotive of a hundred years ago and the modern locomotive.

Figs. 1 to 3, pp. 660 and 661.

(From *Engineering*.)

The exhibit of the London & North Eastern Railway, figure 1, is of historic as well as present interest as it contrasts the locomotive of a hundred years ago with the modern unit required to handle the heavy expresses of the London to Leeds service and the East Coast route. Next year will be the centenary of British railways. Locomotive building was of earlier date, since before they were used for railway working locomotives had been employed on colliery lines and sidings. In 1825, however, the first railway, as such, was opened. The line was intended for coal traffic and goods, but on the opening day numbers of people travelled by the train which made the first trip, and the experience led to a demand that passengers should be conveyed as well as goods and coal. Thus, quite unintentionally, the Stockton and Darlington line became the first railway to start the development of this form of transport in Great Britain, and the country had the honour of being the pioneer of the world as regards a system of communication which has led to greater changes on the face of the earth than any other invention of man. To George Stephenson we owe the success of the Stockton line. The credit for this is often given to Edward Pease, to whose enterprise, determination, and business ability the undertaking was undoubtedly due. But it must be remembered that the line as originally decided upon was relatively badly aligned and that steam power had not been even contemplated when Pease set it afoot. It was not till George Stephenson took charge, as the company's engineer, that the alignment was improved, and it was wholly due to Stephenson's faith in steam traction that powers were obtained to employ locomotives, and that a trial was given to this form of haulage. Stephenson's faith was justified, and the first locomotive to be used on a public railway performed, for those days, extremely creditably. After a strenuous life this engine has, fortunately, been preserved for us, and as a relic of national value fittingly finds place in the exhibition of the British Empire, which railways have done so much to develop. The old engine, *Locomotion No. 1*, which we illustrate in figures 1 and 2, is not quite as it was originally built. The changes introduced, however, do not mar its value as an early presentation of locomotive design and construction. The cylindrical boiler, of 3/8 inch plates, was 4 feet in diameter, and the internal flue 22 inches in diameter. The two cylinders were 10 inches in diameter with a stroke of 24 inches. The cylinders were placed vertically over the axles, and the greater part of each, together with the steam chest, was inside the steam space. The piston rods were provided with cross-bars which were constrained to move each in a vertical plane by means of parallel motions. Reversing was accomplished by means of a loose eccentric, the valve gear being disconnected, the valves reversed by hand, and the gear recoupled again (1). At Wembley this engine is driven by an electric

(1) See *Bulletin of the International Railway Association*, March 1921, p. 312, in which a paper from Mr. J. Dunlop, entitled: « The development of locomotive valve gear », gives a description of the valve motion of the engine *Locomotion No. 1*.

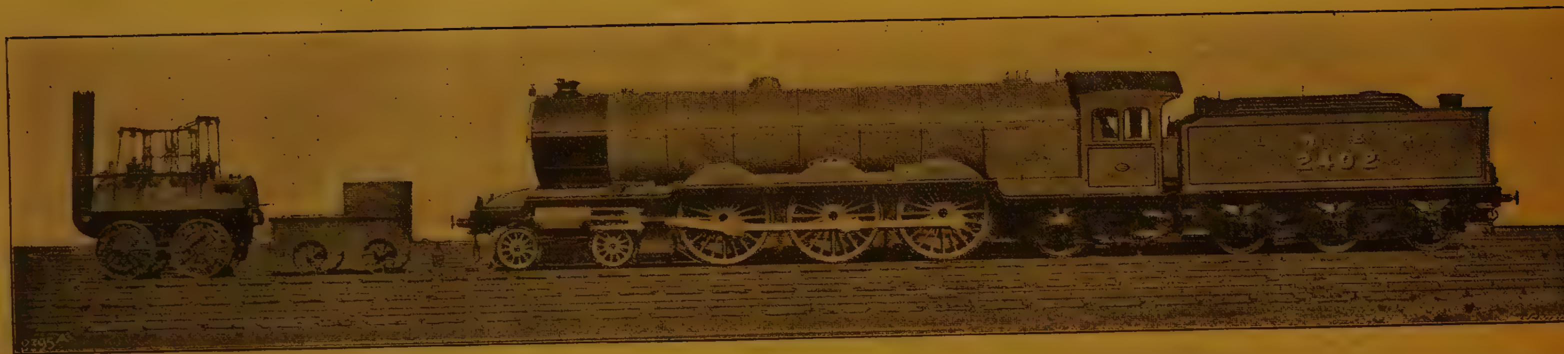


Fig. 1. — *Locomotion No. 1*, built in 1825; *City of York* of the *Pacific* type, built in 1924.

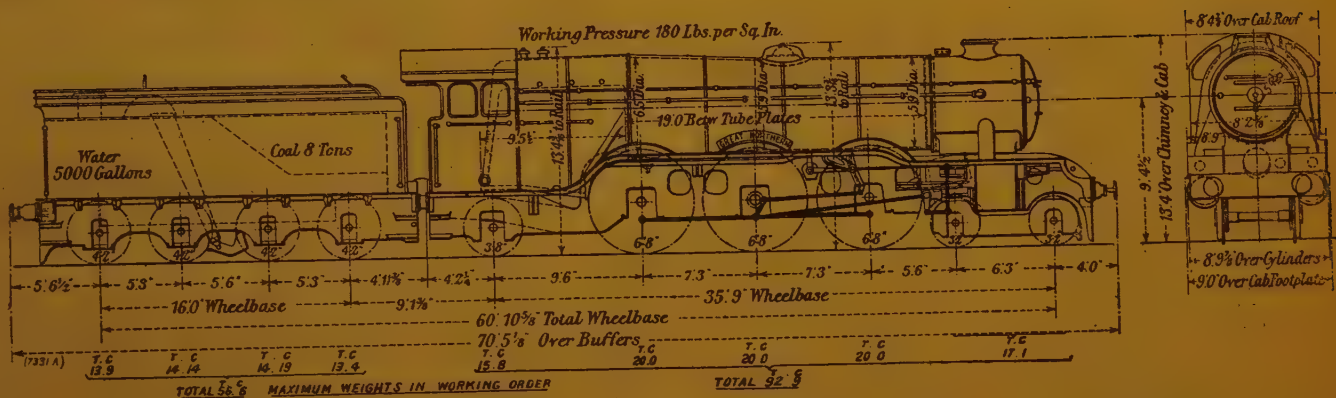


Fig. 3.

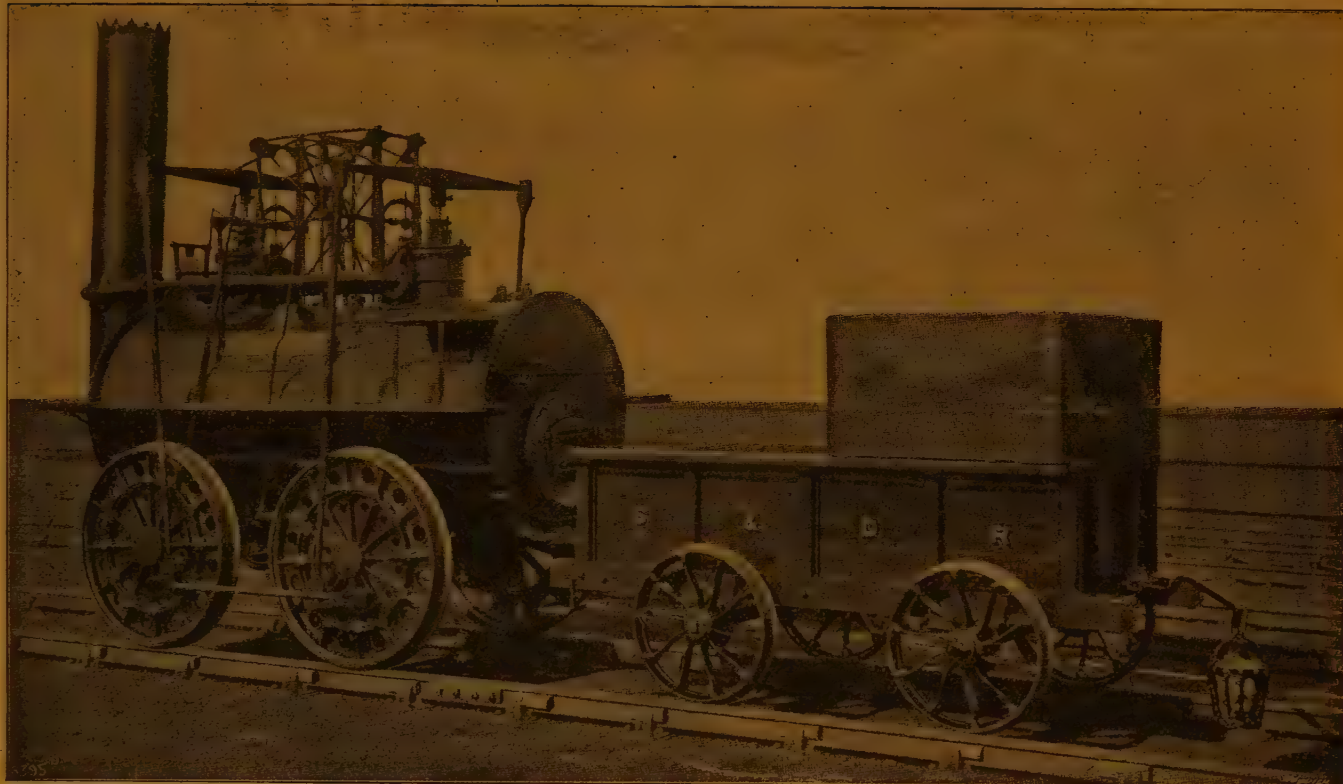


Fig. 2. — *Locomotion No. 1*, constructed for the Stockton & Darlington Railway by Messrs. Robert Stephenson & Co.

motor so that the valve motion will be seen at work. Steam pressure from 25 lb. to 50 lb. was carried. The boiler was fed by pump and the exhaust was carried into the chimney by means of a breeches pipe. A bell was provided, whistles not having then been introduced. A fire devil was hung from the tender buffer beam. The regulator handle was connected to a regulator rod passing through a stuffing box into the boiler. The rod was fitted with a double crank coupled to a flat valve working across the base of the steam chest.

On the opening day of the railway this engine hauled a load of about 90 tons, at one part of the trip attaining a speed of 15 miles per hour. The contract price was £500, which was also the figure paid for a second engine delivered to the railway by Messrs. Robert Stephenson some two months or so after the opening. The contrast between this early machine, whose promise was so problematical that horse traction was concurrently employed on the Darlington line, and the product of modern design shown alongside it in figure 1 is striking indeed. The *City of York* shown in that view is one of the class of 4-6-2 engines built recently at Darlington. The engine at Wembley is one of the sister class built at Doncaster to Mr. H. N. Gresley's design. It is well shown in figure 3. The one hundred years which have elapsed have made imperative machines capable of handling over 600 t. at an average speed of over 50 miles per hour and maximum speed of over 70 miles per hour. To meet these requirements Mr. Gresley introduced in 1922, on the then Great Northern, engines which constituted a considerable advance on previous British practice. 12 locomotives of this class had been built by the end of 1923, while 40 more are to be completed this year (1).

Locomotion No. 1 of the Stockton and Darlington weighed about 6 1/2 tons. No. 4472 of the London North Eastern 4-6-2 class weighs, with tender, 148 t. 15 cwt. The latter has three cylinders, and a boiler whose largest diameter is 77 inches and possesses many unusual features. The chief of these is the form of the fire-box, which is fitted with a combustion chamber after the manner of engines on the Pennsylvania Railroad, while the superheater elements are provided with much shorter return bends than is common practice.

The boiler barrel has one parallel course connected with the fire-box shell by means of a taper course, the under side of which is horizontal. The dome is situated on the parallel course. The longitudinal joints are butt joints with double butt straps, and are quadruple-riveted. The fire-box is of the wide form first adopted in this country in Mr. Ivatt's *Atlantics*, but, as above noted, fitted with a combustion chamber. The latter makes a more perfect system of radial staying possible; roof bars and palm stays are not employed. The grate is partly horizontal, but sloped towards the front end, at which part a drop section is fitted. This, it may be remarked, is a device which has always been strangely neglected in this country. At the front end the smoke-box extension of the front course of the barrel is bolted to a saddle. At the back end the fire-box is carried by castings extending between the frames. Expansion brackets hold the box down at the sides, and shoes on the foundation ring give support at the back end. The boiler is fitted with a steam turret from which several of the mountings are piped. The regulator is worked by an inverted lever on each side of the fire-box, fitted on a cross shaft which passes through two stuffing-boxes in a mounting enclosing a short arm coupled to the regulator rod.

The frames are 1 1/8 inches thick. They are well stayed at the front buffer beam, bogie centre, the inside cylinder, yoke for the inside slide bars, and at the fire-box and back end, while a stiff steel casting is situated between the second and third coupled axle and at this point support is given to the boiler barrel, with allowance for lateral movement.

The cylinders, as previously stated, are three in number, all driving on to the middle coupled axle. The two outside cylinders are

(1) *The Bulletin* of February 1923 (« British Locomotives in 1922 », by J. F. Gairns) has already given the main features of this engine, as also that of the locomotive belonging to the old « North Eastern Railway ».

horizontal and on the driving-axle centre line. The inside cylinder is further to the rear and is inclined at 1 in 8, so that the rod may clear the first coupled axle. The exhaust passages for the outside cylinders communicate with the blast pipe by way of the saddle. Those for the inside cylinder are complete in the casting. The blast pipe combines all by means of a branch connection to the inside cylinder casting. The valves are all horizontal and in the same plane. Each cylinder has a separate steam pipe from the superheater header. Those for the outside cylinders pass through the sides of the smoke-box to the upper side of the steam chest.

The valve gear is of the Walschaert's type in the case of the outside cylinders. The inside cylinder valve is operated indirectly on the principle previously adopted by Mr. Gresley. This arrangement involves two horizontal rocking levers connected with the outside cylinder-valve tail rods. Roller bearings are fitted to the large lever at the fulcrum-pin and pivot-pin of the short lever.

The pistons and rods are forged in one piece of nickel-chrome steel and the piston rod is bored out to reduce the weight of the reciprocating parts. The pistons have a bronze ring cast round the head to reduce wear. Two snap rings are used. The return cranks of the Walschaerts gear are fitted with ball bearings. Reversing is by screw, the gear being fitted with ball bearings and with a power lock operated by the vacuum maintained for the brake. Simultaneously a Ferodo-lined clutch worked by the vacuum comes into action on the weigh-bar shaft.

The connecting and coupling rods are of nickel-chrome steel heat-treated with an ultimate tensile strength of 50 tons per square inch and yield-point 80 % of the tensile strength. The big-ends of the outside connecting rods are plain bushed eyes. The inside-rod big-end has a semi-circular cap held to the T-end of the rod by two bolts solid with the cap. Among the smaller details, it may be mentioned that the cylinder cocks are operated by Bowden wire.

[**621 .134.1** (.73)]

2. — Performance tests of the locomotive « booster ».

Figs. 4 to 7, pp. 664 and 665.

(From the *Railway Review*.)

The fitting of a « booster » to locomotives [1] provides a temporary increase in the adhesive weight when the maximum drawbar pull is required. This applies particularly to starting or when running over hilly sections at low speeds, when the power developed is limited not by the boiler, but by adhesion.

The weight on the trailing axles of locomotives with large fireboxes is often almost equal to that on the driving axles, so that the additional adhesion is found to be approximately 50 % for an *Atlantic* type locomotive (4-4-2), 33 1/3 % for a *Pacific* (4-6-2), 25 % for a *Mikado* (2-8-2) and 20 % for a *Santa Fe* (2-10-2).

This result is obtained without carrying out any alterations affecting the running of the locomotive at high speed, since the number of coupled axles remains the same. The « booster » only operates at low speeds and is automatically cut out on reaching a certain speed.

The first tests were made on a 4-4-2 locomotive. The results obtained are shown on the diagram figure 4 which shows the tractive effort at various speeds with and without the « booster ». It is seen that the latter is in operation up to 22 miles per hour, and that the increase in starting effort is 36 %. A second test was made on a *Pacific* type locomotive, and the trials made gave the

[1] See the *Railway Congress Bulletin* for January 1921, p. 92, and December 1923, p. 1102 for articles on this subject.

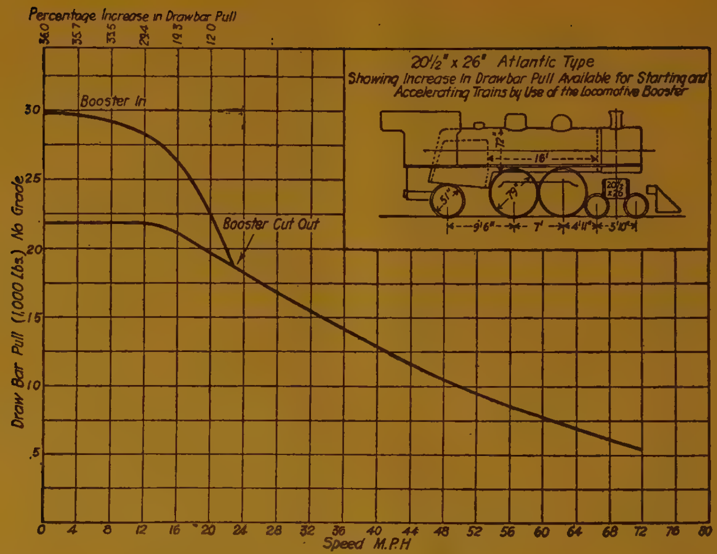


Fig. 4. — Tractive effort curves with and without a « booster » for an *Atlantic* type locomotive.

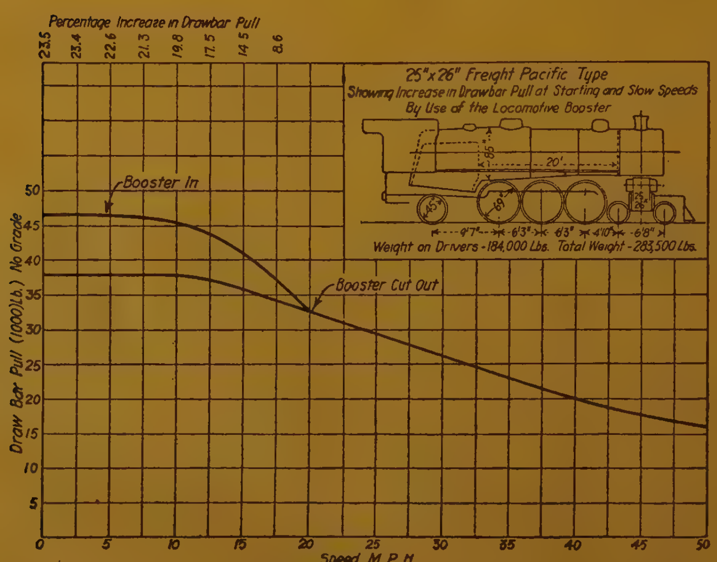


Fig. 5. — Tractive effort curves with and without a « booster » for a *Pacific* type locomotive.

results shown on diagram figure 5. The increase in drawbar pull due to the « booster » is 23 % at starting.

The increase in drawbar pull at low speeds not only results in greater acceleration, but also provides a means of maintaining a higher speed on gradients.

Figure 6 refers to a 2 500 t. (1) train worked by a *Pacific* type locomotive over various gradients. The dotted lines represent

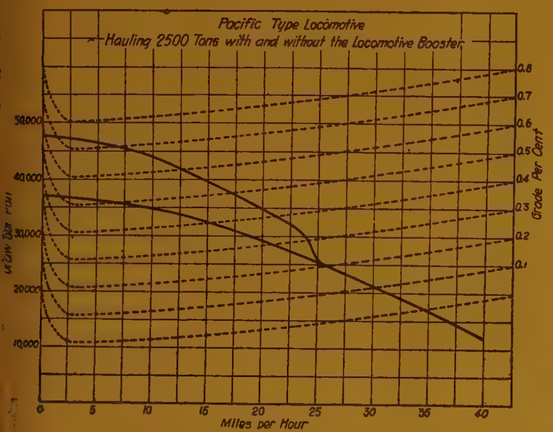


Fig. 6. — Speeds obtained with a *Pacific* type locomotive hauling 2 500 t. with and without a « booster » on gradients up to 0. 6 %.

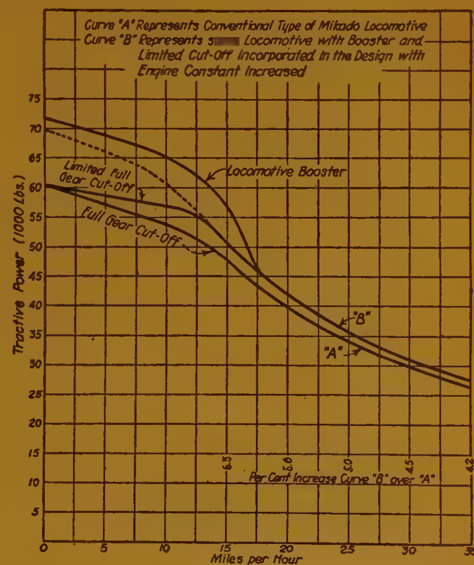


Fig. 7. — Improved tractive effort curve obtained by fitting a « booster » combined with increased cylinder diameter and limited full gear cut-off.

the resistance of the train running at a steady speed on gradients up to 0.6 % (1 in 166). Each additional 0.1 % rise in grade corresponds to an increase of 5 000 lb. in the resistance. The curves plotted show clearly the variation in drawbar pull with and without the « booster ».

It will be seen that the acceleration increases to a greater extent than does the drawbar pull. Thus, the drawbar pull rises from 37 000 to 47 000 lb., which is an increase of 27 %, but the force available for acceleration, which is the difference between the drawbar pull and the resistance, just after starting on the level, is 47 000 — 11 000 lb. in place of 37 000 — 11 000, that is to say, an increase of $\frac{10\,000}{26\,000} = 38.5\ \%$. Furthermore, the improvement is more noticeable on gradients than on the level. On a gradient of 0.3 % (1 in 333), the fitting of a « booster » brings the power available for acceleration up to 47 000 — 25 500 instead of 37 000 — 25 500, an increase of $\frac{10\,000}{11\,500} = 87\ \%$. If the weight of the engine and tender is taken as 400 000 lb., the acceleration on a gradient of 0.3 % will be, without the « booster », equal to

$$\frac{(37\,000 - 25\,500) \times 32\ 2}{2\,700 \times 2\,000} = 0.069 \text{ feet}$$

(1) The tons referred to in this article are American short tons, *viz.*, 2 000 lb.

per second per second, while with the « booster » it will be equal to

$$\frac{(47\,000 - 25\,500) \times 32.2}{2\,700 \times 2\,000} = 0.128 \text{ feet}$$

per second per second

Figure 6 shows clearly the increase obtained in the steady speed which was maintained on the gradients. On a gradient of 0.4 % without the « booster » it was not possible to exceed 15 miles per hour, whereas with the « booster », one could maintain 21 miles per hour. These speeds are shown by the points where the resistance and drawbar pull curves intersect. On a gradient of 0.5 % the use of a « booster » brings the steady speed up from 6 to 16 miles per hour. On a 0.6 % gradient the locomotive could not start the train, but with a « booster » a speed of 12.5 miles per hour could be maintained. On a gradient of 0.5 % the increase is $\frac{16 - 6}{6} = 62.5$ %. This represents a great saving of time on a gradient of appreciable length.

The « booster » also makes it possible to run a locomotive with an earlier cut-off. With this object, one may use larger cylinders, and instead of working with a late cut-off when starting in full gear, cut-off comparatively early in the stroke.

In figure 7, the line A refers to the force developed by an ordinary *Mikado* (2-8-2) locomotive, having a static tractive effort of 60 000 lb. The line B represents a locomotive fitted with larger cylinders working with a limited full gear cut-off, but consuming the same quantity of steam. This engine develops 5.6 % more power at 20 miles per hour, but if the ordinary late cut-off were used when starting, the tractive effort represented by the dotted line would reach an initial value of 70 000 lb., and there would be a marked tendency for the engine to slip. By limiting the cut-off in full gear, the tractive effort curve is reduced to the same starting value (60 000 lb.) as that of curve A, and if the action of the « booster » is added to this, it is possible to obtain, without exceeding the limit imposed by adhesion, a greater drawbar pull when starting and more efficient engine at higher speeds.

E. M.

[656 .222.1 (.73)]

3. — Train speeds in America,

By A. L. BOSTWICK.

(*Railway Age.*)

Ten or fifteen years ago it was possible to travel from New York to Chicago in 18 hours; to St. Louis in 24; to Buffalo in 8 1/4, and to Pittsburgh in less than 9. The speediest trains in the world ran from Camden, N. J., to Atlantic City, making 66.6 miles an hour. Expresses on the Reading-Jersey Central route were timed at a mile a minute from Jersey City to the suburbs of Philadelphia.

For various economic reasons these « high spots » have been cut down. The fastest schedules have been lengthened. On the other hand, many slow trains have been accelerated, and the *number* of fast trains has increased. All in all, therefore, there has been considerable progress in furnishing quick transportation by rail, even without the hair-raising performances of some of the « flyers » in days gone by.

The United States still leads the world in long-distance high-speed trains. First in performance comes the New York Central's *Twentieth Century Limited*, covering the 968 miles between New York and Chicago at 48.4 miles an hour, and always running in two or more sections. The double-column shows the more notable long-distance trains.

It is clear that the speediest long-distance trains are confined to two important railway systems and run between the Atlantic seaboard

TABLE 1.

Railroad.	*Train.*	*Run.*	*Distance, in miles.*	*Hours.*	*Minutes.*	*Speed, in miles per hour.*
New York Central	20th Century Limited	New York-Chicago	968	20	0	48.4
New York Central	Detroiter	Detroit to New York	675	14	20	47.1
New York Central	Detroiter	New York to Detroit	675	14	45	45.8
New York Central	Hudson River Limited	Cincinnati to New York	884	19	25	45.5
Pennsylvania	Broadway Limited	New York-Chicago	908	20	0	45.4
New York Central	5th Avenue Special	Chicago to New York	968	21	57	44.0
New York Central	Southwestern Limited	New York to St. Louis	1 158	26	25	43.8
Pennsylvania	Wash.-Broadway Limited	Washington-Chicago	826	19	0	43.5
New York Central	Wolverine	New York-Chicago	958	22	0	43.5
New York Central	Michigan Central Limited	Chicago to New York	958	22	15	43.1
New York Central	Knickerbocker Special	St. Louis to New York	1 158	27	15	42.5
Pennsylvania	New Yorker	St. Louis to New York	1 053	24	50	42.4
Railroad.	*Train.*	*Run.*	*Distance, in miles.*	*Hours.*	*Minutes.*	*Speed, in miles per hour.*
New York Central	Empire State Express	New York to Buffalo	439	9	0	48.7
Pennsylvania	No. 114 and No. 186	Washington to New York	226	4	55	46.0
Pennsylvania	Pittsburgher	New York to Pittsburgh	440	9	35	45.9
New York, New Haven & Hartford	Merchants and Knickerbocker Limiteds	New York-Boston	229	5	10	44.3

and the large cities of the Middle West. In fact there is only long-distance train in the 40-mile-an-hour class that operates outside this territory — the Illinois Central's *Panama Limited*, covering the 921 miles between Chicago and New Orleans at a speed fractionally above the 40-mile mark.

The only other railroad to operate a long-distance train at 40 miles an hour or better is the Baltimore & Ohio, whose *Capitol Limited* makes slightly over that rate between Chicago and Washington, 786 miles, and from Chicago to New York, 1 014 miles.

For medium distances — 200 to 500 miles — some of the best records are made by long-distance trains over portions of their routes. In a number of instances schedules of 50 miles an hour are maintained between cities 200 miles or more apart. The table below does not take such cases into consideration; it lists a few of the principal trains covering medium distances only.

From Harmon, N. Y., to Buffalo, or almost the entire distance from New York, the *Empire State Express* averages 50 miles an hour.

The fastest trains in this country belong in the « short-distance » class, and operate between Camden, N. J., and Atlantic City. The Reading covers distance of 55.5 miles in 54 minutes, at 61.7 miles an hour; the Pennsylvania's average, over a slightly longer line, is 60.7. These runs, while slower than formerly, are still among the fastest in the world.

On the Reading-Jersey Central line between New York and Philadelphia at least one train runs from Bound Brook, N. J., to Jenkintown, Pa., 49.2 miles, in 49 minutes. This and the Atlantic City runs furnish the only instances that can be discovered where American trains are scheduled at mile-a-minute speeds between station stops.

The Reading-Jersey Central two-hour New York-Philadelphia expresses are the only trains in the United States, excepting those on the Camden-Atlantic City routes, that are timed at 50 miles or more an hour *for their entire run*. Jersey City is the real terminus for these trains, and the 90 miles between this point and Philadelphia is covered in 108 minutes. As has been noted already, some very high speeds are made over portions of this route; in some cases over 55 miles an hour.

In one respect at least, Philadelphia fails to live up to its reputation; the city is served by the fastest trains in the United States.

Speeds of 50 miles an hour between regular stops are common on the main lines of the New York Central, the Pennsylvania and the Reading-Jersey Central. One can travel at this rate over such stretches as between Albany and Buffalo, Newark and Philadelphia, Chicago and Fort Wayne, Harrisburg and Altoona, Syracuse and Rochester. On other lines, 50-miles schedules are rare. West of the Mississippi, and in the South, there are few, if any at all.

In New England, the only runs at this rate are performed by the New Haven's *Merchants* and *Knickerbocker* limiteds, westbound, which cover the 62.2 miles between Providence and New London at 51.1 miles an hour. The Lehigh Valley's *Black Diamond Express* runs from Buffalo to Rochester Junction, N. Y., 68.1 miles, at 52.4 miles an hour. The *Capitol Limited* on the Baltimore & Ohio, makes 50.5 miles an hour westbound over the 116.9-mile stretch between Garrett and Gary, Ind. Train No. 19 on the Big Four (New York Central Lines) runs from Hillsboro to Granite City, Ill., near St. Louis, 48.9 miles, at 52.4 miles an hour. On the main line of the Illinois Central, 50-mile schedules are in effect over a few short stretches south of Chicago.

The fastest run of over 100 miles on any American railroad is performed on the Canadian section of the Michigan Central (New York Central Lines) between St. Thomas and Windsor, Ont., by the *Detroiter*, westbound, which runs the distance of 109.6 miles in 113 minutes, at a speed of 58.2 miles an hour. From Buffalo to Windsor, 233 miles, this train averages 52.4 miles an hour, including one 5-minute stop. Several other trains on this same stretch make records almost as good.

West and south from Chicago there are several fast runs, particularly that of the Illinois Central's winter train, the *Floridan*, which reaches Carbondale, Ill., 306.7 miles from Chicago, in 6 hours 40 minutes, the

speed being 46 miles an hour. On parts of the route it approaches 50. The *Panama Limited* on the same stretch does almost as well.

Fast time is made on several lines between Chicago and the Mississippi. The Rock Island's *Rocky Mountain Limited* averages 44.8 miles an hour on the 179.3-mile, stretch between Chicago and Moline, Ill. The Chicago & Alton's train No. 79 runs from Chicago to St. Louis, 283.9 miles, at a speed of 43.7 miles an hour, and reaches Springfield, Ill., in four hours, or 46.3 miles an hour for the 185.1 miles.

The South has very few trains scheduled at speeds as high as 40 miles an hour for any considerable distance. The Illinois Central's *Panama Limited* is the fastest train serving this territory.

West of the Missouri, the best run of over 500 miles is performed by the Union Pacific's *Overland Limited*, eastbound, running 507 miles from Cheyenne, Wyo., to Omaha at 42 miles an hour. Fast time is made on portions of several railroads running between Omaha and Denver, particularly when summer schedules are in effect. At present, the Rock Island's *Rocky Mountain Limited* runs from Limon, Col., to Phillipsburg, Kan., 247 miles, at 44.2 miles an hour.

In the northwest, Oregon Short Line (U. P.) train No. 5, having no through passenger connections, runs 489 miles from Green River, Wyo., to Nampa, Idaho, at the rate of 39.6 miles an hour.

The fastest trains on the Pacific Coast are Southern Pacific Nos. 71 and 72, making 37.3 miles an hour between San Francisco and Los Angeles over the coast route, 475 miles.

Of the so-called « transcontinental » trains, the eastbound *Sunset Limited* of the Southern Pacific makes the highest speed, 35.5 miles an hour over the 1 992 miles from Los Angeles to Avondale, La., across the river from New Orleans.

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1 APPENDIX :

List of the Permanent Commission and of the Local organising Committee of the tenth session (London, June 1925).

OFFICIAL INFORMATION

ISSUED BY THE

PERMANENT COMMISSION

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

Meeting of the Permanent Commission on the 5 July 1924.

The Permanent Commission of the International Railway Congress Association met on the 5 July 1924 at the Head Office of the State Railways, Brussels, with Mr. TONDELIER, president, in the chair.

A number of members of the Local Commission of Organisation for the London Congress were also present.

* * *

I. — The Right Hon. H. G. BURGESS, general manager of the London Midland & Scottish Railway, and Abdul-Hamid Pacha SOLIMAN, director general of the Egyptian State Railways, Telegraphs and Telephones, have been appointed members of the Permanent Commission.

A list of the names of the present members of this Commission is attached.

* * *

II. — The balance sheet for the year 1923, which has been verified by a professional accountant, was passed, and the projected budget for the social year 1924 was approved of.

The variable annual subscription of the participating administrations (article 17 of the statutes) was fixed at 35 centimes per kilometre for the current year 1924.

* * *

III. — The Permanent Commission approved of the proposition of the English Railway Companies' Association as regards filling the vacant places on the Local Commission of Organisation for the London session.

The present composition of this Commission is also given in the attached.

* * *

IV. — On the proposal of the English Local Commission, the Permanent Commission decided that the coming session should take place in June 1925. The opening date is fixed for 22 June.

All the reporters have been asked to send in their reports to the Permanent Commission as soon as possible.

* * *

V. — The Permanent Commission then proceeded to discuss various matters in connection with the organisation of the coming session.

The Congress will be held in the Institution of Civil Engineers and in the Institution of Mechanical Engineers, at Westminster.

The following programme has been provisionally drawn up :

Monday 22 June 1925	morning . . .	Reception of the delegates by the Permanent Commission. Registration of delegates.
	afternoon. . .	Formal opening of the session.

SECTIONAL MEETINGS AND GENERAL MEETINGS.		Section I. — Questions :	Section II. — Questions :	Section III. — Questions :	Section IV. — Questions :	Section V. — Questions :
Tuesday 23 June . . .	morning . . . afternoon . .	III	IV	III	X	XIII
Wednesday 24 June .	morning . . .	III	IV	III	X	XIII
	afternoon .	Visit *Swindon* or other places round London.				
Thursday 25 June . .	morning . . . afternoon . .	I	IX	IX	XI	XIV
	evening . . .	*Banquet.*				
Friday 26 June. . . .	morning . .	II	V	XII	XII	XIV
	afternoon . .	II	V	XII	XII	XV
Saturday 27 June. . .	morning . . .	General meeting.				
	afternoon . .	*Windsor.*				
Sunday 28 June . . .	. . . .	Down River.				
Monday 29 June . . .	morning . . .	II	V	VIII	...	XV
	afternoon . .	Visit *Canterbury*, etc				
Tuesday 30 June . . .	morning . . . afternoon . .	VI	VI	VII	Optional visits to various points of Railway and Historical interest round London for sections without meetings.	
Wednesday 1 July . .	morning . . .	VI	VI	VII		
	afternoon . .	General meeting.				
Thursday 2 July . . .	morning . . .	General meeting.				
	afternoon . .	To *Darlington*				
Friday 3 July.	morning . . . afternoon . .	At *Darlington*.				

SECTIONAL MEETINGS AND GENERAL MEETINGS.	Section I. — Questions :	Section II. — Questions :	Section III. — Questions :	Section IV. — Questions :	Section V. — Questions :
Saturday 4 July	On to *Edinburgh* and then to *Glasgow*, or return to *London*.				
Sunday 5 July	Down *Clyde*.				
Monday 6 July.	Return to London by London Midland & Scottish Route.				

The Committee will urge, through diplomatic channels, the adherent Governments to nominate their delegates.

An invitation will also be shortly sent out to participating Administrations.

* * *

VI. — The following alterations have taken place since the last meeting :

ADMINISTRATIONS.

Admissions :

	Kilom.	Miles.
Uganda Railway	995	618
Polish State Railways .	16 659	10 352
Salentine Railway . . .	243	151
Baltimore & Ohio Railroad	8 347	5 187
Rohilkund & Kumaon Railway	925	575
Cordoba Central Railway	1 934	1 202
The Interprovincial Steam Tramway Company of Milan-Bergamo-Cremona . . .	142	88

Resignations :

	Kilom.	Miles.
Buffalo & Susquehanna Railroad	407	253

The Railway Congress Association now consists of 235 Administrations whose lines comprise 472 400 km. (293 500 miles).

* * *

VII. — REVISION OF THE STATUTES.

The Permanent Commission has considered certain modifications to be made in the statutes of the Association.

It has decided to continue the discussion of these modifications at a meeting to be held in February 1925.

The new statutes thus amended will be submitted for the approval of the Association at one of the general meetings to be held during the London Congress.

General Secretary,
J. VERDEYEN.

President,
V. TONDELIER.

APPENDIX.

LIST OF MEMBERS OF THE PERMANENT COMMISSION

OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

President :

V. **Tondelier** (1), administrateur-président honoraire, membre du conseil d'administration des chemins de fer de l'Etat belge; rue de Louvain, 17, Bruxelles.

Vice-presidents :

F. **Bruneel** (2), administrateur-président en disponibilité, membre du conseil d'administration des chemins de fer de l'Etat belge; rue du Monténégro, 106, Bruxelles;

C. **Colson** (2), membre de l'Institut, inspecteur général des ponts et chaussées, vice-président du Conseil d'Etat de France; rue de Laplanche, 2, Paris.

Members of the Executive Committee :

G. **Behrens** (3), director, London Midland & Scottish Railway; Chepstow street, 20, Manchester;

The Right Hon. Sir Evelyn **Cecil** (1), G. B. E., M. P., privy councillor, director, Southern Railway; Cadogan Square, 2, London, S.W.1;

Griolet (3), vice-président du conseil d'administration de la Compagnie du chemin de fer du Nord français; avenue Henri Martin, 97, Paris.

Ex-president of session, member ex-officio:

R. de **Cornè**, ingénieur, président du conseil supérieur des travaux publics d'Italie; Rome.

Members :

Belgium.

V. **Tondelier** (already named);

F. **Bruneel** (already named);

C. **Hanrez** (2), administrateur en disponibilité, membre du conseil d'administration des chemins de fer de l'Etat; rue d'Alsace-Lorraine, 16*a*, Bruxelles;

H. **Vander Rijdt** (1), administrateur en disponibilité, membre du conseil d'administration des chemins de fer de l'Etat; avenue Eugène Plasky, 71, Bruxelles;

E. **Foulon** (3), administrateur des chemins de fer de l'Etat; Bruxelles;

A. **Braem** (3), administrateur des chemins de fer de l'Etat; Bruxelles;

J. **Verdeyen** (2), ingénieur en chef, inspecteur de direction aux chemins de fer de l'Etat; Bruxelles;

H. **Caufriez** (1), directeur général de la Société nationale belge des chemins de fer vicinaux; rue de la Science, 14, Bruxelles;

G. **Philippe** (3), inspecteur général des lignes Nord belges; Liége.

China.

Tsang Ou (2), directeur général adjoint du chemin de fer du Lunghai; rue de Mogador, 5, Paris.

Denmark.

T. A. **Alstrup** (3), directeur général des chemins de fer de l'Etat; Gl. Kongevej, 1, Copenhague.

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(1) Retires at the 10th session.
(2) Retires at the 11th session.
(3) Retires at the 12th session.

Egypt.

Abdul-Hamid Pacha **Soliman** (2), directeur général des chemins de fer, télégraphes et téléphones de l'Etat; Le Caire.

Spain.

A. **Valenciano y Mazerès** (2), ingénieur en chef des ponts et chaussées, sous-directeur général des travaux publics et chef de la section des chemins de fer au Ministère du fomento; Calle de Piamonte, principal derecha, 14, Madrid;

Maristany (3), marquis de l'Argentera, directeur général de la Compagnie des chemins de fer de Madrid à Saragosse et à Alicante; Estacion de Atocha, Madrid;

United States of America.

D. **Willard** (1), chairman of the Board, American Railway Association, president, Baltimore & Ohio Railroad; Baltimore, Md.;

R. H. **Aishton** (3), president, American Railway Association; South Dearborn Street, 431, Chicago, Ill.;

L. F. **Loree** (3), president, Delaware & Hudson Railroad; Nassau Street, 32, New York City;

W. W. **Atterbury** (1), vice-president, Pennsylvania Railroad System; Broad Street Station, Philadelphia, Pa.

France.

C. **Colson** (already named);

E. **du Castel** (2), conseiller d'Etat, directeur général des chemins de fer au Ministère des travaux publics; boulevard Saint-Germain, 241, Paris;

M. **Fontaneilles** (2), inspecteur général des ponts et chaussées, président de la section des chemins de fer au conseil général des ponts et chaussées; rue de Sèvres, 4, Paris;

P. **Riboud** (2), directeur de la Compagnie des chemins de fer de l'Est; rue d'Alsace, 21, Paris;

J. R. **Paul** (3), directeur de la Compagnie des chemins de fer du Midi; boulevard Haussmann, 54, Paris (IXe);

G. **Griolet** (already named);

J. B. **Javary** (1), directeur de l'exploitation de la Compagnie du chemin de fer du Nord; rue de Dunkerque, 18, Paris;

Margot (3), directeur général de la Compagnie des chemins de fer de Paris à Lyon et à la Méditerranée; rue Saint-Lazare, 88, Paris;

A. **Mange** (1), directeur de la Compagnie du chemin de fer de Paris à Orléans; rue de Londres, 8, Paris.

Great Britain.

J. R. **Brooke** (1), C. B., permanent secretary, Ministry of Transport; Whitehall Gardens, 6, London, S. W. 1;

The Right Hon. Viscount **Churchill** (1), G. C. V. O., chairman, Great Western Railway; Paddington Station, London, W. 2.;

G. **Behrens** (already named);

Sir Guy **Granet** (2), G. B. E., chairman, London Midland & Scottish Railway; Lombard Street, 80, London, E. C. 3;

The Right Hon. H. G. **Burgess** (2), general manager, London Midland & Scottish Railway; Euston Station, London, N. W. 1;

The Right Hon. Sir Evelyn **Cecil**, G. B. E., M. P. (already named);

Sir Francis **Dent** (3), C. V. O., director, Southern Railway; Porthyfelin, Holyhead.

Canada.

H. G. **Kelley** (3), past president, Grand Trunk Railway System; Sherbrooke street, 731, West, Montreal, Que.

Italy.

R. de **Cornè** (already named);

Abdelcader **Fabris** (1), ingénieur, chef du service du matériel et de la traction des chemins de fer de l'Etat; Florence;

Felice **Fiori** (1), ingénieur, inspecteur supérieur à la Direction générale des chemins de fer de l'Etat; Rome;

Riccardo **Gioppo** (3), ingénieur, inspecteur supérieur à la Direction générale des chemins de fer de l'Etat; Rome;

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(1) Retires at the 10th session.
(2) Retires at the 11th session.
(3) Retires at the 12th session.

F. Tajani (1), ingénieur, président de la Fédération des transports; via Nirone, 21, Milan.

Japan.

J. **Aoki** (2), inspecteur général au Ministère des chemins de fer; Tokyo.

Holland.

L. M. **Barnet Lyon** (3), ingénieur civil, membre du conseil de surveillance des chemins de fer; Statenlaan, 14, La Haye.

Poland.

A. **Frank** (1), ingénieur des ponts et chaussées, inspecteur au Ministère des chemins de fer; Varsovie.

Rumania.

C. **Mereutza** (2), sous-directeur général des chemins de fer roumains; Bucarest.

Sweden.

A. **Granholm** (2), directeur général des chemins de fer de l'Etat; Stockholm.

Switzerland.

Le Dr. R. **Herold** (1), directeur au département fédéral des postes et des chemins de fer; Berne;

Zingg (2), président de la direction générale des Chemins de fer fédéraux; Berne;

G. **Kunz** (1), directeur du chemin de fer Berne-Loetschberg-Simplon; Berne.

Czecho-Slovakia.

E. **Kejr** (3), ingénieur, conseiller des constructions du département V/1 au Ministère des chemins de fer; Prague.

Administrative Councillor : A. **Braem** (already named).

SECRETARY'S OFFICE : rue de Louvain, 17, Brussels.

General Secretary : J. **Verdeyen** (already named).

Secretary-Treasurer : Ed. **Holemans**, inspecteur de direction honoraire des chemins de fer de l'Etat belge.

Assistant Secretary-Treasurer :

J. **Habran**, inspecteur de direction aux chemins de fer de l'Etat belge.

Assistant Secretaries :

R. **Desprets**, ingénieur principal aux chemins de fer de l'Etat belge;

E. **Minsart**, ingénieur principal aux chemins de fer de l'Etat belge.

ENGLISH SECTION OF THE PERMANENT COMMISSION.

(Local organising Committee of the tenth session.)

President :

The Right Hon. Viscount **Churchill**, G. C. V. O., chairman, Great Western Railway; Paddington Station, London, W. 2. (Member of the Permanent Commission).

Vice-presidents :

The Right Hon. Sir Evelyn **Cecil**, G. B. E., M. P., privy councillor, director, Southern Railway; Cadogan Square, 2, London, S. W. 1. (Idem);

(1) Retires at the 10th session.
(2) Retires at the 11th session.
(3) Retires at the 12th session.

Gustav **Behrens**, director, London Midland & Scottish Railway; Chepstow Street, 20, Manchester (Idem).

Members :

The Minister of transport; Whitehall Gardens, 6, London, S. W. 1.;

The Right Hon. Lord **Aberconway**, P. C., chairman, Metropolitan Railway; Belgrave Square, 43, London, S. W. 1.;

The Right Hon. Lord **Ashfield**, P. C., chairman and managing director, Metropolitan District Railway; Electric Railway House, Broadway, London, S. W. 1.;

F. A. **Brant**, continental traffic assistant, Southern Railway; Victoria Station, London S. W. 1.;

J. R. **Brooke**, C. B., permanent secretary, Ministry of transport; Whitehall Gardens, 6, London, S. W. 1. (Member of the Permanent Commission);

The Right Hon. H. G. **Burgess**, general manager, London Midland & Scottish Railway; Euston Station, London, N. W. 1. (Idem);

Sir Francis **Dent**, C. V. O., director, Southern Railway; Porthyfelin, Holyhead (Idem);

Sir Hugh **Drummond**, Bt., C. M. G., chairman, Southern Railway; Eaton Place, 98, London, S. W. 1.;

Sir Henry **Fowler**, K. B. E., deputy chief mechanical engineer, London Midland & Scottish Railway; Derby;

A. L. **Gibson**, continental traffic manager (south), London & North Eastern Railway; Liverpool Street Station, London, E. C. 2.;

Sir Guy **Granet**, G. B. E., chairman, London Midland & Scottish Railway; Lombard Street, 80, London, E. C. 3. (Member of the Permanent Commission);

The Right Hon. Lord **Lawrence** of **Kingsgate**, director, London Midland & Scottish Railway; Eaton Square, 23, London, S. W. 1.;

A. **Maynard**, assistant goods manager and development agent, Great Western Railway; Paddington Station, London, W. 2.;

Sir Felix **Pole**, general manager, Great Western Railway; Paddington Station, London, W. 2.;

Sir Herbert A. **Walker**, K. C. B., general manager, Southern Railway; Waterloo Station, London, S. W. 1.;

Sir Ralph Lewis **Wedgwood**, C. B., C. M. G., chief general manager, London & North Eastern Railway; King's Cross Station, London, N. 1.;

Wm. **Whitelaw**, chairman, London & North Eastern Railway; Hatton House, Kirknewton Midlothian.

Secretary :

Arthur B. **Cane**, C. B. E., secretary, Railway Companies' Association; Parliament Street, 35, Westminster, London, S. W. 1.

ARRANGEMENTS COMMITTEE.

Chairman :

Sir Evelyn **Cecil**, G. B. E., M. P.

Members :

Gustav **Behrens**;

Sir Felix **Pole**;

Sir Ralph Lewis **Wedgwood**, C. B., C. M. G.;

The Right Hon. H. G. **Burgess**;

Sir Herbert A. **Walker**, K. C. B.;

F. A. **Brant**;

A. L. **Gibson**;

Sir Henry **Fowler**, K. B. E.;

A. **Maynard**;

SUB COMMITTEE OF ARRANGEMENTS COMMITTEE.

F. A. **Brant**;

A. L. **Gibson**;

Sir Henry **Fowler**, K. B. E.;

A. **Maynard**;

H. **Marriott**, C. B. E.